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EcoAgriTourism, in the light of its multidisciplinary character, is a wide-open journal which brings together the opinions of specialists from both academic and economic environment, fostering fruitful collaborations.

The journal's structure covers all aspects of the fields approached, the focus being on original and current researches with applications in agriculture, food industry and rural tourism. Collaborators may feel free to undertake biological and technical aspects as well as aspects with social, cultural and environmental impact. Information of general interest is also welcome for the agriecology-food-tourism axis

Prof. Romulus Gruia Ph. D.

The Journal of EcoAgroTurism aims at approaching analyses, methodologies, options and references within the journal's framework.



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INCREASING THE QUALITY OF LIFE BY OPTIMISING AGRI-GASTRONOMIC ELEMENTS

The principles of sustainable development applied to the field of "eco-agri-tourism" mean bringing the environment into the economic equation and raising the educational and cultural level of consumers with regard to quality food. The expected effect is to raise the quality of life and optimise networks on the 'farm to fork' axis. One direction to follow is the short network from agro-zootechnical to culinary production, i.e., the AGRI-GASTRONOMIC AXIS.

For Romania, the development of agro-gastronomic networks through the development of short circuits and geographical proximity between agricultural producers, restaurateurs and consumers is a solution that is gradually taking shape. It is a multi-purpose and bio-harmonising course of action that aims to harmonise economic indicators between the components of the agri-food system in the direction of profit for agri-zootechnical producers (farms), food industry processors (factories) and hospitality industry ("HORECA") and traders (retail).

It is also a convenience for the consumer of quality food because these networks can lead to the correlation of product standards in Romania both at national level ("STAS"), at European level (directives, recommendations), and at farm and public food establishment level, which is necessary for agricultural products and culinary preparations of all kinds: industrial, manufactured and especially original and/or traditional local. In addition, the correctness of information and communication on the components of the agri-food axis can also be monitored, with clues for consumers based on the correct labelling system or the menu displayed in the restaurant industry.

The AGRI-GASTRONOMIC NETWORKS therefore simplify things and support quality of life.

Director of the publication,

Prof. Romulus GRUIA, PhD,
PhD supervisor, Scientific Leader

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USE OF MARINE BIOMASS RESOURCES AS RAW MATERIAL IN BAKERY

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Abstract: The pressure on global food systems is likely to increase in the coming years. Population growth, increasing urbanization and changes in eating habits are trends that set the stage for a growing demand for food. The UN's Food and Agriculture Organization (FAO) has estimated that projected demand requires a 70% increase in global food production by 2050. A sustainable blue economy is part of the EU's strategy to increase the use of marine resources to produce new foods and food supplements. Increased use of marine resources for alternative food production will help alleviate pressure on land resources for agriculture, in addition to mitigating climate change and ensuring food security and sustainability.

The paper presents the objectives, research methodology and part of the results of the ERANET SuMaFood project (www.sumafood.eu). SuMaFood is an international partnership between 3 industrial partners, 3 universities and R&D research institutes from Greece, Norway, Romania and Spain, coordinated by SINTEF Energy Research (Norway). The objective of the project is to design new and innovative methods of processing and preservation, including improved solutions for fish residue separation and fractionation, low temperature stabilization, hydrolysis and drying. In addition, macroalgae (seaweed *Saccharina Latissima*) raw materials were dried, analyzed and tested as a food ingredient. The ingredients, (seaweed *Saccharina Latissima* and hydrolyzed cod fish protein) were supplied in the form of a powder with reduced moisture and were included separately in various baking recipes, with a replacement degrees of wheat flour of 0%, 1.5%, 3 %, 4.5%, 6%.

Chemical potential, rheological and enzymatic properties, as well as consumer acceptability were evaluated. Textural analyzes were performed for 96 hours of storage. The results showed great nutritional potential, given the high value of fish proteins as well as the high fiber content, Ca, Fe, P, K, Mg, I, in the case of the algae used. The rheological and enzymatic analyzes were carried out with the Mixolab equipment and the Chopin + method, according to the ICC173 standard and showed very good baking characteristics in the case of additions of a maximum of 4.5% of hydrolyzed proteins. In the case of the addition of algae, the breadability characteristics are maintained at acceptable values for a degree of substitution of a maximum of 3%.

The sensory evaluation of the bakery products obtained showed a pronounced after-taste in the case of fish protein, which limited the addition to a value of 1.5%. In the case of algae, consumers penalized the sour, salty and bitter taste of bakery products with the addition of 4.5% and 6%. Textural analyzes of bread samples showed an increase in firmness and gumminess over time and with increasing algae addition; in the case of fish protein, an increase in firmness and a decrease in cohesiveness were observed over time and with increasing protein addition.

Experimental research on bakery samples offers exciting possibilities for the use of marine resources, aiming at a safe and secure future food system.

Keywords: marine biomass, bakery, functional food

1. Introduction

The latest research shows that marine biomasses and by-products can be made available and attractive as raw material in food industry. In this regard, several aspects of innovative improvements to supply systems is addressed, including sorting and handling, drying technologies, cooling and freezing, and determination of other sustainable pre-processing and preservation techniques. The main purpose of research is to increase the use of raw materials, demonstrate waste reduction, enhance product quality and stability, extend product ranges, and to provide unique products in a growing marine food chain.

Also, another approach is to demonstrate significant energy savings and reduced CO₂ emissions in processing technologies, thereby contributing to a lower carbon footprint and increased sustainability in blue bioeconomy value chains [1-3].

Rest raw materials (RRMs) have limited shelf-life due to high rate of biochemical reaction and microbial activity. The value chain of the most types of RRM is limited to fish oil extraction, fish meal and biogas.

The reason for this is absence of business cases and system solutions for efficient pre-treatment of RRM at fish processing factories and slaughterhouses. Thus, the one aim of many scientific efforts work is to investigate methods for stabilization and separation of RRM at slaughterhouses prior to further processing..

The objectives are follows:

1. Develop sustainable and safe fractioning strategy of RRM for production of food-grade products.
2. Determine methods and design efficient process of RRM stabilization by chilling and freezing.
3. Determine optimal parameters of hydrolysis process and oil separation for selected types of RRM

4. Develop stabilization of FHP using evaporation and freeze-concentration methods.

Fractioning and redirection of different flows of RRM give an opportunity to split food-grade RRM from feed-grade. The immediate and continuous pre-processing of fresh RRM at fish processing factories and slaughterhouses plays an important role for RRM increased value and diversification of the use of the final product. Production of fish protein hydrolysates (FPH) is one of the most sustainable ways of pre-processing for food-grade. It is a mixture of peptides with a high nutrition value and high diversity of further processing methods. Additional advantages of FPH are continuous processing, pasteurization technologic step, higher oil yield during separation, when compared with traditional fish meal production.

At the same time, production of FPH has several challenges, which should be solved before the FPH is implementation in the processing lines:

- Oxidation of fish lipids and fish smell
- Low stability of liquid FPH
- Handling of co-products, which occurs

during the hydrolysis process, bones and skin remains [7]

The applied novel drying technologies lead to the production of aquatic biomass powders that can be used as food (including re-structured and nutritional products), food ingredients, or feed. The paper results also address post-processing techniques to enable enhanced preservation and stability of such biomass powders.

Very important is to reach out to the downstream stages of the value chain by addressing challenges connected to transport and storage, and the ultimate shelf-life of biomass products. Correct packaging of products thus can increase shelf-life considerably and contribute to reduced waste [5, 6, 9-13].



Fig. 1. The concept of biomass valorization in food & cosmetic industry (SUMAFOOD project, 2021)

The proposed approach will actively work towards increased consumption of seafood at the European level through the introduction of new seafood meals and the use of aquatic sources in food products. The consumer acceptance will be evaluated by a representative panel testing in the project.

Enhanced food production from marine biological resources should contribute to reduced pressure on land resources for agriculture, mitigate climate change, and enable future food security and sustainability. Overall, the paper results will contribute to the promotion and growth of the entire EU blue bioeconomy value chain [10-12, 14].

2. Methodology

Two types of powder of marine biomass were obtained, one from *Saccharina Latissima* and another from hydrolysed protein from cod fish were used for processing bakery products.

At the salmon slaughterhouse, a technique for separation and fractioning of fish residues was developed, and the physical and chemical properties of the residues was determined to establish the preferable pre-processing method and to distinguish between food- and feed-grade rest raw materials [4, 8, 14].

The rest raw materials like fish left over (skin, heads, bones, viscera) exist in two forms, a

frozen state, and a chilled state. The rest raw material is frozen to temperatures of approximately -18°C . The chilled form of RRM is maintained at temperatures $+3^{\circ}\text{C}$ approx. In this step, The RRM is first thawed from a lower temperature of -18°C to 10°C if it is in the frozen state. The Energy demands during this process are relatively high since in addition to the sensible heat above freezing and below freezing point, the latent phase change of the ice is also accounted.

Once the RRM is thawed, the next step involves preparing the RRM for the hydrolysis process. In this process, the RRM is finely crushed into smaller mixtures. Crushing is usually powered using mechanical coarse grinders followed by fine ones. The proper grinding of the RRM is very important since this affects the hydrolysis time. The smaller the materials the more quickly the proteins in the structure dissolve. During this step, an equivalent amount of water, usually 1:1 was added to the mixture and minced properly for the hydrolysis process. When using Cod fish heads, the water per cent can be lowered since the heads have a lot of moisture. The specific heat before mining and after mincing was determined based on state temperatures and are used in the calculation. The amount of water added during the process is highly important to have a better breakdown of protein molecules and this also determines the cost of drying during the

process. During the hydrolysis process, the solution is heated to hydrolysis temperature of 50 - 55 °C and the enzymes were added to the RRM mixture. Heating the mixture to the hydrolysis temperature consumes a large amount of energy. Knowing the specific heat capacity of the solution and the mass flow rate, the heat flow and energy demand are calculated. Once the entire solution reaches the required hydrolysis state, the hydrolysis process begins. Generally, the hydrolysis process can take up to 60-120 mins and in some cases even longer time. The temperature and process parameters are well controlled during the entire process and the mixture is uniformly stirred during the entire process to have a uniform temperature distribution.

Hydrolysis processes are very unstable and depends on different factors such as variation in amino acid composition of proteins, lipid content, conditions of the rest raw materials, temperature, pH of hydrolysis mixture, rate of cooling and heating etc., the same is true for oil separation after hydrolysis.

Thus, it is extremely important to determine optimal parameters and boundaries for operation of the hydrolysis system and variation of the hydrolysate properties. For this purpose, modular system for hydrolysis and oil separation (NUAS prototype) need to be tested at a slaughterhouse during two seasons. The

properties for the RRM will be determined for each batch. Quality of liquid hydrolysate from each batch need to be analysed by: proximate composition, hydrolysis index, oil yield and fish odour.

This will allow to make a conclusion concerning the adjustment of the hydrolysis parameters such as temperature, time, pH, RRM flow and mixing rate. This allow to develop efficient control strategy for the system.

Quality analyses were done according to European Commission Regulation (EC) No 2073/2005.

The powder was be analyzed for content of myco-toxins and heavy metals. Nutritional analyses, such as water content, proteins, lipids, total carbohydrates, and minerals, was conducted and the potential for human health benefits was checked to design new food recipes. The samples were tested for potential health benefits for humans (antioxidant activity and total polyphenols).

For rheological properties was used the research methods according Mixolab technology, Chopin protocol, and the maximum level of wheat flour replacement was determined. Sensorial analysis on medium scale will be done to reveal how consumers perceive the appearance, aroma, taste and texture.

Table 1. Coding of experimental samples of wheat flour with the addition of seaweed flour (SW) /Fish protein hydrolysed (FPH)

M	100% wheat flour
1 A/P	98.5 % wheat flour + 1.5 % SW/FPH
2 A/P	97% wheat flour + 3 % SW/FPH
3 A/P	95.5 % wheat flour + 4.5 % SW/FPH
4 A/P	94% wheat flour + 6% SW/FPH

3. Results

In table 2 there are presented a comparison between the main nutritional parameters for the raw materials used: (Seaweed *Sacharina*

Latisima), Fish Protein hydrolysed and Wheat Flour. Se poate constata cantitatea ridicata de proteine in cazul FPH si cantitatea ridicata de fibre si substante minerale in cazul SW.

Table 2. Comparison between the main nutritional parameters for SW, FPH and WF

	SW			FPH			WF650		
	Batch 1	Batch 2	Batch 3	Batch 1	Batch 2	Batch 3	Batch 1	Batch 2	Batch 3
Humidity (%)	7,28	7,06	7,17	2,40	2,42	2,42	13,10	13,09	13,11
Ash (%)	39,27	36,62	40,87	12,68	12,84	12,68	0,69	0,64	0,65
Protein (%)	14,97	13,95	14,11	81,88	80,92	80,84	11,5	11,20	11,42
Total fat (%)	0,69	0,71	0,72	0,65	0,57	0,60	1,2	1,2	1,1
Total sugar (%)	0	0	0	0	0	0	1,1	0,8	0,9
Crude fibre (%)	6,60	6,36	6,14	0,47	0,39	0,45	1,26	1,21	1,23
Sodium chloride (g/100g)	22,14	21,34	21,57	10,32	10,11	10,92	0,00	0,0	0,0

In table 3 is presented the mineral content of the seaweed used, comparing with other results from literature. A high content of I, P, Mg, K, Ca can

be found, elements that open up special opportunities in the design of bakery products that could carry nutritional and health claims.

Table 3. Major mineral and trace elements determined by ICP-OS of cultivated *S. latissima* harvested at different time and depth

Minerals (of d.m.)	Other Literature Values	Our results - ICP-OES
K (g/kg)	25.5-109 [29,30]	62.197
Na (g/kg)	12.3-60 [29,30]	15.201
Ca (g/kg)	1.3 [29]	8.273
Mg (g/kg)	7.9 [29]	6.067
Fe (mg/kg)	133.9 [29]	37
Se (mg/kg)	0.05 [31]	ND
Cu (mg/kg)	2.3 [29]	0.85
Mn (mg/kg)	10.4 [29]	4.0
Cr (mg/kg)	0.4-5.9 [29]	ND
Mo (mg/kg)	0.4 [28]	ND
Zn (mg/kg)	44.4-81.0 [29,31]	30.0
I (g/kg)	2.7-3.5 [28,31]	12.6
P (g/kg)	4.0-4.4 [29,30]	2.3

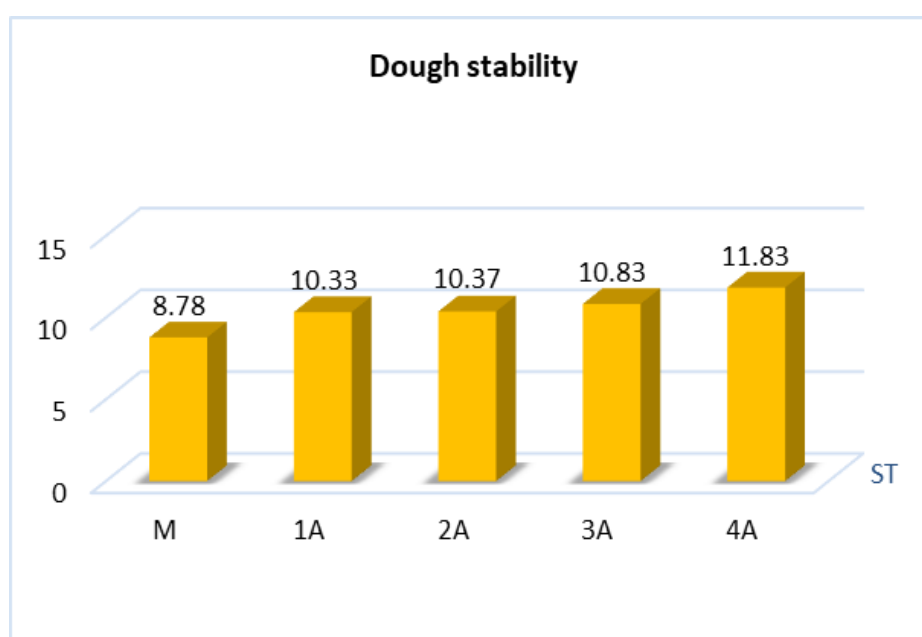
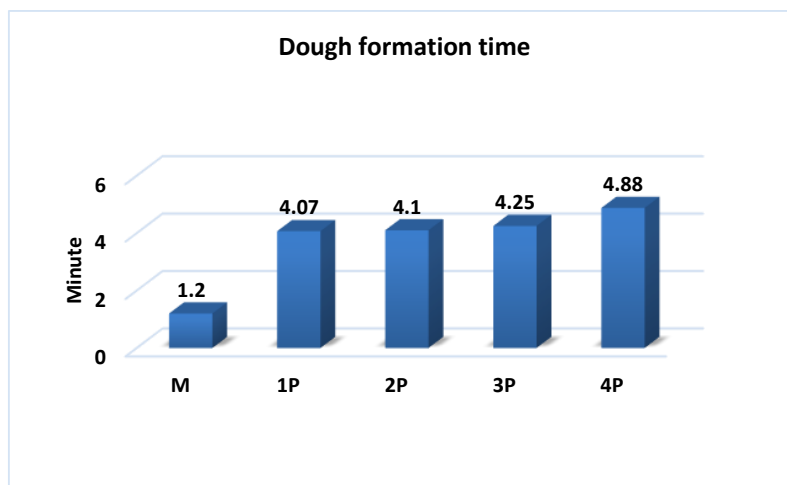
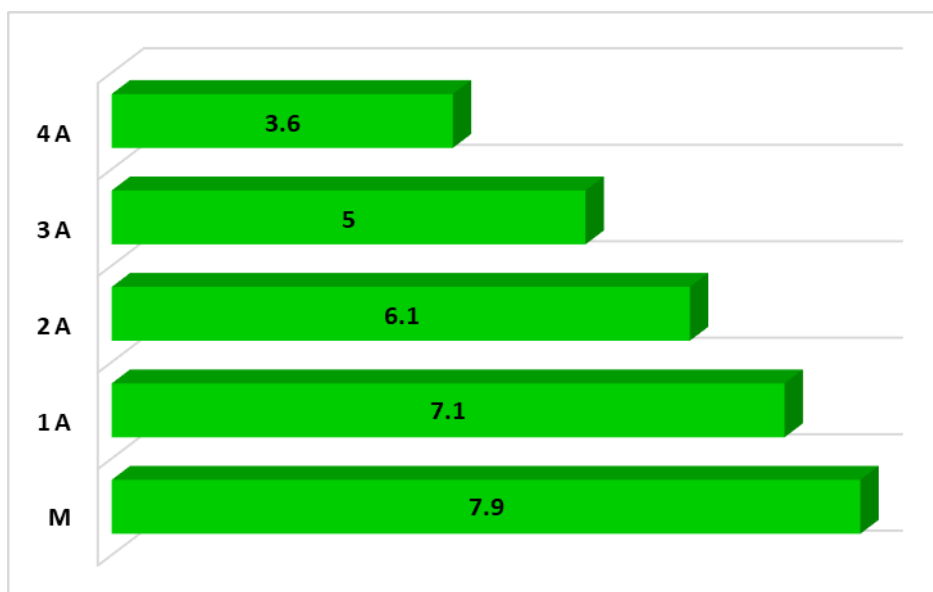


Fig.2. *The influence of alga flour addition on dough stability***Fig. 3.** *The influence of FPH addition on the dough forming time*

In figures 2 and 3 can be observed interesting phenomena occurred by the addition of seaweed (fig. 2) and fish protein (fig. 3): dough

stability increased 34% and dough formation time increased by 306,6%.

**Fig. 4.** *The results of the sensory analysis obtained through analysis of acceptance tests - bread with algae flour*

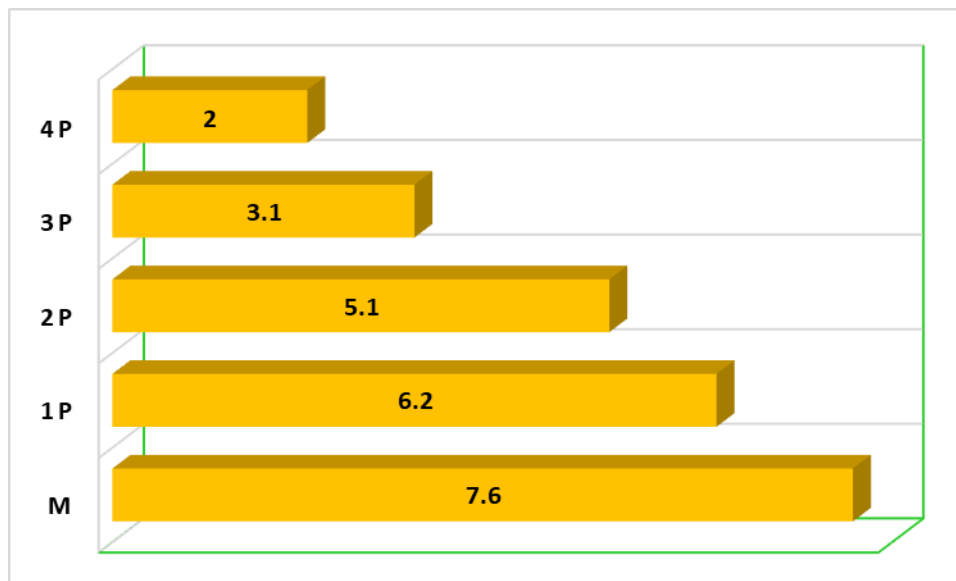


Fig. 5. The results of the sensory analysis of bread samples with the addition of fish meal obtained through analysis of acceptance tests

In figure 4 and 5 there are presented the results of the sensory analysis of bread samples, from where can be concluded that the samples: 1A (1,5% algae), 2A (3% algae) and 1P (1,5% fish protein) can be considered for human consumption.

Conclusions

Reduced production of waste from blue bioeconomy value chains, through innovative utilization of by-products and raw materials from fisheries and aquaculture, will contribute vitally to the joint UN and EU Sustainable Development Goal 12.3 to achieve zero waste.

- Utilization of marine species and increased production growth within sustainability limits require improved techniques for food preservation and product quality.
- Reduced energy consumption and CO₂ emissions in the blue bioeconomy supply systems is possible by developing of energy-efficient processing technologies (drying and refrigeration processes) and will contribute to a reduced costs and consumption of energy, while improving the quality of the biomasses.
- The aims presented in the paper reduce overall environmental footprint in the whole supply chain by the introduction of energy-efficient processing technologies, the demonstration of natural refrigerants with a low climate impact,

and the production of high-concentration, nutritious biomass powders with scaled-down storage and transport costs to the market.

- The paper is promoting sustainable and healthy marine and aquatic food products. Due to their nutritional benefits (high protein levels, omega-3 fatty acids, and vitamins), the advancement of increased seafood consumption is leading to positive effects on the overall public health through a reduction of lifestyle related diseases, such as diabetes and obesity, and an increased access to high-nutrient food products.
- The results are promoting an increased European consumption of seafood through the introduction of new seafood meals and the use of marine sources as ingredients in other food products (bakery products, instant soups, etc.). Future research will work towards market uptake of such products by analysing the market potential, investigate the legal framework for food grading, and deliver knowledge about measures that will enhance food-based products and feeds.

References

1. Ghosh, P. R., Fawcett, D., Sharma, S. B., and Poinern, G. E. J., Progress towards Sustainable Utilisation and Management of Food Wastes in the Global Economy, International Journal of Food Science vol. 2016, Article ID 3563478, (2016).
2. <http://www.fao.org/3/a-i2697e.pdf>

3. Campoy-Muñoz, P., Cardenete, M. A., and Delgado, M. C., Economic impact assessment of food waste reduction on European countries through social accounting matrices, *Resour. Conserv. Recycl.* 122, 202–209 (2017).
4. https://ec.europa.eu/research/social-sciences/pdf/policy_reviews/global-europe-2050-report_en.pdf
5. <http://www.fao.org/resources/infographics/infographics-details/en/c/317265/>
6. Winther, U., et al., Carbon footprint and energy use of Norwegian seafood products, SINTEF Report No. SFH80 A096068 (2009)
7. FHL, ENVIRONMENTAL REPORT; Norwegian Seafood Industry Emphasizing facts and figures from 2012 up to July 2013-2; www.fhl.no (2013)
8. Je, J. Y., Qian, Z. J., Byun, H. G., and Kim, S. K. Purification and characterization of an antioxidant peptide obtained from tuna backbone protein by enzymatic hydrolysis, *Process Biochem.* 42, 840–846 (2007)
9. Villamil, O., Váquiro, H. & Solanilla, J. F. Fish viscera protein hydrolysates: Production, potential applications and functional and bioactive properties, *Food Chemistry* vol. 224, 160–171 (2017)
10. Moses, J. A., Norton, T., Alagusundaram, K. & Tiwari, B. K. Novel Drying Techniques for the Food Industry, *Food Eng. Rev.* 6, 43–55 (2014)
11. Özçelik, M. and Püschner, P.-A., Microwave Plant Requirements and Process Control for Advanced Applications, In: *The Microwave Processing of Food*, Woodhead Publishing, p. 350-380 (2017)
12. Bantle, M., Kvalsvik, K. H. & Tolstorebrov, I. Performance simulation of a heat pump drying system using R744 as refrigerant, *Refrig. Sci. Technol.* 244–251 (2016), doi:10.18462/iir.gl.2016.1037
13. Lourenço, S. C., Moldão-Martins, M. & Alves, V. D. Antioxidants of natural plant origins: From sources to food industry applications, *Molecules* vol. 24 (2019)
14. Gómez-Estaca, J., López-de-Dicastillo, C., Hernández-Muñoz, P., Catalá, R., and Gavara, R., Advances in antioxidant active food packaging, *Trends in Food Science and Technology* vol. 35, 42–51 (2014).

THE URBAN BIODIVERSITY OF M'SILA CITY (ALGERIA)

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Abstract: The objective of this study is to analyze the urban biodiversity of the city of M'sila geographical space limited to the northeast of the province. The green framework of the city of M'sila manifests itself in two forms: private and public green spaces very diversified in terms of flora and fauna. In this context, the methodology adopted is an inventory of the taxonomic diversity of this green framework. The city of M'sila presents a very important flora and vegetation which contains 119 species belonging to 49 families and 103 genera. From the biological and morphological type point of view, the tree stratum is the most dominant with 37%, shrubby (35%) and the herbaceous stratum has more than 28%. In ethnobotany, multiple uses of the species are medicinal, toxic, ornamental and foods are recorded. The faunal inventory of the city of M'sila lists 50 species belonging to 33 families and 16 orders, of which the class of insects is the most dominant. In conclusion, field observation on the one hand showed a great difference in specific richness between the different sites studied in the city of M'sila and, on the other hand, there is a degradation of several gardens and green spaces such as the Ahmed Madaghri garden and the November 1, 1954 garden.

Keywords: Urban ecosystem, biodiversity, flora and fauna inventory, M'sila, Algeria.

1. Introduction

Today, about 80% of the population resides in urban areas. Biodiversity in the city largely depends on the promotion of green spaces, which has become an absolute necessity for maintaining the quality of life of the population. The preservation and development of urban biodiversity can only have beneficial effects at the ecological, aesthetic, social and even psychological level, by improving the well-being of the inhabitants [1]. Very few research works concern the biodiversity of the urban ecosystem of the city of M'sila. It is in this vision that the objective of this present work is the presentation of the taxonomic biodiversity of some gardens and green spaces of the city of M'sila, it is based on the floristic inventory, the faunal inventory and the management of this biodiversity.

2. Materials and Methods

2.1 Presentation of study area

Our investigation area is located in the eastern center of Algeria, which covers an area of 18,718 km². It is made up of 47 municipalities grouped into 15 divisions (Fig. 1). The M'sila region is located at an altitude of 500 m, is geographically located between 35°42'07" N 4°32'49" E. The climate of the investigation area is of the continental type subject in part to Saharan influences [2]. The summer is dry and very hot while the winter is very cold, with low rainfall and irregular, it is around 100 to 250 mm/year. In addition, the study area is characterized by two ecosystems: forest and steppe. This feature gives M'sila the name of capital of Hodna.



Fig. 1. Location of the study area

2.2. Methodology

From March to May 2015, the flora and fauna inventory was carried out with the aim of establishing the list of flora and fauna. In addition, the inventory was limited around the gardens, green spaces and the main boulevards of the city. Botanical determinations were made by comparison with reference works devoted to flora and vegetation [3-6]. Regarding the fauna, determinations were made by specialists in entomofauna from the department of agronomic sciences of the University of M'sila.

3. Results and Discussion

3.1. Flora analysis

The inventoried plant species are divided into one hundred and nineteen species, forty-nine families and one hundred and three genera. The families with the greatest specific diversity are Asteraceae with fourteen species, Rosaceae, Fabaceae, Oleaceae, Malvaceae, Poaceae and Palmaceae with 11, 8, 7, 6 and 5 species respectively (Tab. 1).

Table 1: Frequencies of genera and species inventoried in the city of M'sila

Families	Number of Genera	Number of Species	Families	Number of Genera	Number of Species
Asteraceae	14	14	Solanaceae	1	1
Rosaceae	6	11	Zygophyllaeae	1	1
Fabaceae	8	8	Agavaceae	1	1
Oléaceae	4	7	Ampélidaceae	1	1
Malvaceae	4	6	Apocynaceae	1	1
Palmaceae	3	5	Araliaceae	1	1
Poaceae	5	5	Convolvulaceae	1	1
Apiaceae	4	4	Crassulaceae	1	1
Moraceae	2	4	Pittosporaceae	1	1
Liliaceae	3	3	Platanaceae	1	1
Cruciferae	3	3	Primulaceae	1	1
Nyctaginaceae	2	2	Punicaceae	1	1
Anacardiaceae	2	2	Acanthaceae	1	1
Bignoniaceae	2	2	Buxaceae	1	1
Cactaeae	2	2	Cannaceae	1	1
Césalpinaceae	2	2	Euphorbiaceae	1	1
Cupressaceae	2	2	Lamiaceae	1	1
Verbenaceae	1	2	Lythraceae	1	1
Aizoaceae	2	2	Musaceae	1	1
Mimosaceae	1	2	Myrtaceae	1	1
Pinaceae	2	2	Oxalidaceae	1	1
Rutaceae	2	2	Papavéraceae	1	1
Passifloraceae	1	1	Thymeleaceae	1	1
Salicaceae	1	1	Rhamnaceae	1	1
Casuarinaceae	1	1	-	-	-

The morphological types listed are dominated by trees with 36% dominated by the following families: Fabaceae (*Acacia*, *Robinia*, *Sophora*), Palmaceae (*Washingtonia*, *Phoenix*) and Pinaceae (the Aleppo pine), followed by shrubs with 35% dominated by the following families: Oleaceae (*Jasminum*), Apocynaceae and Rosaceae then herbaceous with 29% dominated by the families Asteraceae and Poaceae (Fig. 2).

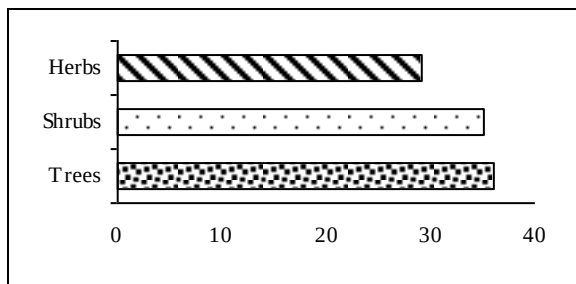


Fig. 2. Stratification of the flora of M'sila city.

The analysis of the floristic inventory identifies several types of plants such as:

Food plants: *Ceratonia siliqua*, *Citrus limon*, *Ficus carica*, *Malus pumila*, *Opuntia ficus-indica*, *Phoenix canariensis*, *Prunus domestica*, *Prunus armeniaca*, *Punica granatum* et *Vitis vinifera*.

Ornamental plants: *Casuarina equisetifolia*, *Eucalyptus globules*, *Cecus peruvianus*, *Opuntia*

ficus-indica, *Ricinus communis*, *Hisbiscus rosa-sinensis*, *Lantana camara* et *Canna indica*.

Poisonous plants: *Nerium oleander*, *Peganum harmala* et *Spartina townsendii*.

Medicinal plants: *Pistacia lentiscus*, *Ferula communis*, *Hedera helix*, *Calendula officinalis*, *Matricaria recutita*, *Sonchus arvensis*, *Bellis annua*, *Chrysanthemum coronarium*, *Scolymus hispanicus*, *Cecus peruvianus*, *Opuntia ficus-indica*, *Ceratonia siliqua*, *Moricandia arvensis*, *Didesmus aegypticus*, *Erysimum grandiflorum*, *Cupressus sempervirens*, *Ricinus communis*, *Rosmarinus officinalis*, *Malva moschata*, *Malva parviflora*, *Hisbiscus rosa-sinensis*, *Ficus carica*, *Morus alba*, *Musa Sapientum*, *Eucalyptus globules*, *Olea europaea*, *Jasminum angulare*, *Fraxinus velutina*, *Papaver rhoeas*, *Rossiflora coerulea*, *Pinus helenpensis*, *Punica granatum*, *Prunus domestica*, *Malus pumila*, *Citrus limon*, *Populus nigra* et *Peganum harmala*.

The presence of very many trees along the Boulevards presents a degradation in particular at the level due Boulevard (Larocade-Ichebilia), this situation is due to the lack of interest on the other hand the boulevard (BBA-Bou Saada) remains the best laid out (Tab. 2).

Table 2: The alignment trees of the Boulevards of the M'sila city

Species names	Boulevard (Larocade – Ichebilia)	Boulevard (College central - University pole)	Boulevard (BBA -Bou Saada)
<i>Schinus molle</i>	121	95	257
<i>Morus alba</i>	57	132	56
<i>Skimmia japonica</i>	13	77	21
<i>Pinus helenpensis</i>	-	8	-
<i>Eucalyptus globules</i>	-	16	52
<i>Pistacia lentistul</i>	62	65	1
<i>Washingtonia robusta</i>	33	2	23
<i>Washingtonia filifera</i>	57	17	278
<i>Phoenix canariensis</i>	13	-	168
<i>Phoenix dactylifera</i>	2	8	8
<i>Olea europaea</i>	-	58	10
<i>Cupressus sempervirens</i>	-	11	23
<i>Casuarina equisetifolia</i>	3	-	78
<i>Daphne gnidium</i>	11	24	-
<i>Platanus orientalis</i>	1	1	20
<i>Fraxinus pennsylvania</i>	7	12	-
<i>Sorbus aucuparia</i>	2	-	-
<i>Acacia sp</i>	3	9	08
<i>Nerium oleander</i>	-	-	133
Total : 19 espèces	385	535	1136

3.2. Fauna analysis

The animal species inventoried are divided into fifty species, thirty-three families and sixteen orders (Fig. 3). These results are obtained following the application of different capture methods, although some species have escaped

capture and identification. The Hymenoptera order is the most represented with 9 species followed by the Beetles order with 6 species. In addition, the group of Insect species dominates this fauna diversity of this study (Tab.3-4).

Table 3: Inventory of fauna diversity in the M'sila city

Order	Families	Species names
Hymenoptera	Formicidae	<i>Cardiocondyla sp, Camponotus ligniperda, Larius nigre</i>
	Apidae	<i>Apis mellifira, Xylocopa violacea</i>
	Vespidae	<i>Paravespula vulgaris, Polistes gallicus</i>
	Sphecidae	<i>Sceliphron destillatorum, Ammophila sabulosa</i>
Diptera	Muscidae	<i>Muscidae sp</i>
	Calliphoridae	<i>Lucilia caesar</i>
Heteroptera	Pyrrhocoridae	<i>Pyrrhocoris apterus</i>
	Miridae	<i>Deraeocoris ruber</i>
	Lygaeidae	<i>Lygaeus saxatilis scopli, Heterogaster</i>
Beetles	Chrysomelids	<i>Clytra quadripunctata</i>
	Coccinellids	<i>Coccinella algerica, Coccinella septempunctata</i>
	Tenebrionidae	<i>Adesmia sp</i>
	Carabidae	<i>Carabus glabratus</i>
	Tenebrionidae	<i>Blaps sp</i>
	Cerambycidae	<i>Acanthocinus aedilis</i>
Embioptera	Forficulidae	<i>Forficula auricularia</i>
Orthoptera	Orthoptera	<i>Acrotylus sp</i>
	Catantopidae	<i>Miramella alpina</i>
	Tetrigidae	<i>Tetrix subulata</i>
Lepidoptera	Pieridae	<i>Gonepteryx rhamni, Pieris sp, Pieris brassicae</i>
	Nymphalidae	<i>Araschnia levana</i>
	Caterpillar	<i>Cossus Cossus</i>
Arachnid	Araneidae	<i>Araneide sp.1, Araneide sp.2</i>
Gastropods	Helicidae	<i>Helicidae sp, Cernuella virgata</i>
Columbiforms	Colombidae	<i>Streptopelia senegalensis, Streptopelia decaocto, Columba livia</i>
Riforms	Passeridae	<i>Passer domesticus, Passer hispaniolensis, Passer domesticus hispaniolensis, Serinus serinus</i>
	Turdidae	<i>Turdus merula</i>
	Corvidae	<i>Corvus corax</i>
Ciconiiforms	Ciconiidae	<i>Ciconia ciconia</i>
Bucerotiforms	Upupidae	<i>Upupa epops</i>
Anseriforms	Anatidae	<i>Anser sp.</i>
Carnivores	Felines	<i>Felis sp.</i>
Lagomorphs	Leporidae	<i>Oryctolagus cuniculus</i>

Table 4: List of insects identified in the M'sila city

Species names	Families	Species names	Families
<i>Apis mellifira</i>	Apidae	<i>Forficula auricularia</i>	Forficulidae
<i>Adesmia sp</i>	Tenebrionidae	<i>Gonepteryx rhamni</i>	Pierides
<i>Acanthocinus aedilis</i>	Cerambycidae	<i>Larius nigre</i>	Formicidae
<i>Acrotylus sp</i>	Orthoptera	<i>Lucilia caesar</i>	Calliphoridae
<i>Ammophila Sabulosa</i>	Sphecidae	<i>Lygaeus saxatilis scopli</i>	Lygaeidae
<i>Araschnia levana</i>	Nymphalidae	<i>Miramella alpina koll.</i>	Catantopidae
<i>Blaps sp</i>	Tenebrionidae	<i>Muscidae sp</i>	Muscides
<i>Camponotus ligniperda</i>	Formicidae	<i>Paravespula vulgaris</i>	Vespidae

<i>Carabus glabratus</i>	Carabidae	<i>Pieris sp</i>	Pierides
<i>Cardiocondyla sp</i>	Formicidae	<i>Pieris brassicae</i>	Pierides
<i>Clytra quadripunctata</i>	Chrysomelids	<i>Polistes gallicus</i>	Vespidae
<i>Coccinella algerica</i>	Coccinellidae	<i>Pyrrhocoris apterus</i>	Pyrrhocoris
<i>Coccinella septempunctata</i>	Coccinellidae	<i>Sceliphron destillatorum Illiger</i>	Sphecidae
<i>Cossus Cossus</i>	Caterpillar	<i>Tetrix subulata</i>	Tetrigidae
<i>Deraeocoris ruber</i>	Miridae	<i>Xylocopa violacea</i>	Apides



1 : *Acanthocinus aedilis* 2 : *Forficula auricularia* 3 : *Pieris brassicae* 4 : *Columba livia*
5 : *Cernuella virgata* 6 : *Deraeocoris ruber* 7 : *Blaps sp* 8 : *Acrotylus sp* 9: *Passer domesticus*

Fig. 3. Some fauna species of the M'sila city

3.3. State of green spaces

The most represented plant species in the sampled sites are: *Schinus molle*, *Cupressus sempervirens*, *Morus alba*, *Rosa* sp, *Bougainvillea glabra*, *Daphne gnidium*, *Skimmia japonica* and *Phoenix* sp. A variation of the floristic diversity marks certain sites of significant richness (the university of M'sila, the

green space of the courthouse (Chahid) and the green space of the city of 500 dwellings), but other sites present a net degradation (the green space of the November 1, 1954 garden, green space linked to the Theatre, green space near the Ben Tabi promotion and the Ahmed Madeghri garden (Fig. 4-5). But Chahid square remains among the sites sampled best equipped.



Garden 1st november Photo
in 1995 [7]



Garden 1st november Photo
« CHOUBAR et AICHE, 2012
»



Garden 1st november
Photo « SARRI M, 2015 »

Fig. 4. Dynamics landscape of the Garden 1st November in the M'sila city



Garden Ahmed Madeghri in 1995 [7]



Garden Ahmed Madeghri Photo « CHOUBAR et AICHE 2012 »

Fig. 5. Dynamics landscape of the Garden Ahmed Madeghri in the M'sila city

Conclusion

The biodiversity of the city of M'sila has made it possible to inventory 119 species belonging to 49 families and 103 genera. The tree stratum is the most dominant with 36%, shrubby (shrubs and shrubs) 35% and the herbaceous stratum accounts for 29%.

In signal, a great variation of specific richness, between the various zones and sectors of the town of M'sila and the degradation of several gardens and green spaces like the garden Ahmed Madaghri and the garden of November 1, 1954. The faunal inventory of the city of M'sila lists 50 species belonging to 33 families and 16 orders, of which the class of insects is the most dominant.

The conservation, enhancement and management of this heritage, requiring the efforts of the institutions of the city M'sila and environmental associations, neighborhood associations and scientists so that this urban ecosystem offers us life services close to nature.

References

1. Bekkouch I., Kouddane N., Daroui E., Boukroute A., Berrichi A., Inventaire des arbres d'alignement de la ville d'Oujd. *Nature et Technologie*, 5 (2011) 87-91.
2. Le Houerou H.N., Bioclimatologie et Biogéographie des steppes arides du Nord de l'Afrique. Diversité biologique, développement durable et désertisation, option méditerranéennes série. B10, (1995).
3. Ozenda P., Flore du Sahara septentrional, Paris, Ed. CNRS, (1983).
4. Quezel P., Santa S., Nouvelle flore de l'Algérie et des régions désertiques méridionales, Paris, Centre national de la recherche scientifique, (1962-1963).
5. Blamey M., Grey-wilson C., Toutes les fleurs de Méditerranée, Lausanne, Édit. Delachaux et Nestlé, (1993).
6. Bayer E., Buttler K., Finkenzeller X., Grau J., Guide de la flore méditerranéenne, Paris, (2005).
7. Mili M., L'espace vert entre nécessités et enjeux : cas des espaces verts publics de la ville de M'sila. Mémoire de Magister. Gestion et Technique Urbaines. M'sila : Université Mohamed Boudiaf de M'sila, (2001). 249.

RESEARCH ON OBTAINING A DIETARY-HYPERPROTEIN DAIRY PRODUCT WITH DIFFERENT ADDITIONS

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Abstract: Milk is a dairy product recognized as a complete food, containing essential components for human nutrition. The aim of the work is to create a hyper protein milk with different ingredients, these being analyzed from a sensory, physico-chemical and microbiological point of view, which were kept for a period of time at refrigeration temperatures

Keywords: hyper-protein, health, nutrition, cinnamon

1. Introduction

Since ancient times, milk has been the most complete food and the easiest to assimilate, contributing to the maintenance of the health of the body, to its normal growth and development, especially in the case of children and adolescents and the elderly [1]. Also, milk is considered a strategic food because it contributes to improving the quality of human life, but it also contributes to ensuring food security, being a basic and complete food [2]. Drinking milk is increasingly consumed throughout the world, being on the top of consumption as well as one of the most sold dairy products, being considered as one of the important elements in a healthy and balanced diet [3,4]. In the last period of time there is a concern related to the development of some functional foods that are closely related to the growing demand of consumers to have a balanced diet [5]. The use of these foods contributes to maintaining or even improving health [6].

The development of products that ensure health benefits is the result of accepting the idea that food has a determined role in the prevention and treatment of certain diseases [7]. From this point of view, the nutritional policy is based on the promotion of new foods, with high biological potential, processed either from raw materials with valuable content in biologically active compounds, or by using methods that increase their nutritional potential [8].

The importance of proteins in food as bioactive factors is determined by the fact that in deficiency there is a decrease in metabolic capacity, decrease in enzyme activity, reduction

in energy metabolism, inhibition of biosynthesis processes, decrease in immunity and resistance of the body to the action of external agents [9]. Likewise, foods intended for special uses are characterized by the fact that due to their special composition or manufacturing process, they can be easily distinguished from foods intended for normal consumption and are suitable for nutritional purposes [10].

Currently, both globally and domestically, these products are prepared using different additives, usually flavoring additives such as milk with fruit or fruit juice, chocolate milk, milk flavored with cocoa, vanilla, citric acid, etc. Protein milk is an assortment of consumer milk, which is obtained from skimmed milk, which is concentrated to a minimum protein content of 5.5%, being the assortment used as a dairy product rich in proteins.

The purpose of this work was to carry out a comparative study from a sensory, physical-chemical and microbiological point of view, of some types of milk for consumption with additives during a certain period of storage.

2. Materials and methods

2.1. Preparation of samples

We chose hyper-protein milk, which is an assortment of consumer milk, which is obtained from skimmed milk, the milk used to be a skimmed milk purchased from an organic farm in Sibiu County, to which tapioca and cinnamon were added. The technological process of obtaining samples of milk for consumption follows the classic process. Hyper-protein milk with tapioca is an assortment of consumer milks

that come with a protein supplement. Tapioca is obtained by wet grinding the root of the Cassava plant, originally from Brazil, but which later spread throughout South America and Africa.

The name cassava is generally applied to the roots of the plant, while tapioca is the name given to the starch and other processed products. The large-sized center of cassava roots is the starch-reserve pulp and can vary in starch content from 15% to 33% [11].

Manuka or Cassava is a drought-tolerant staple food crop grown in tropical and subtropical areas where many people are undernourished, making it a potentially valuable food source for developing countries [12]. Both its roots and leaves are suitable for human consumption; the first as a source of carbohydrates and the second as a source of protein, minerals and vitamins, especially carotene, calcium and phosphorus [13]. Tapioca is a white powder with a moisture content below 13%. The pH of a suspension in water is neutral. Tapioca starch is very mild and clean in flavor and does not mask the flavors used. It is used as a water binding and texturizing agent. It has high viscosity, water holding capacity and binding abilities [14]. Tapioca starch is distinguished from other starches by its low level of residual material, lower amylose content than other amylose-containing starches, and high molecular weights of amylose and amylopectin [11].

Today, tapioca is sold all over the world and enjoys popularity among people oriented towards a healthy lifestyle. According to an article by Medical News Today [15], this powder has qualities such as low cholesterol, high calcium, iron and other minerals, high carbohydrate content, a good source of protein compared to other vegetables, and does not have the ability to form gluten, which led to the development of products that use tapioca as a substitute for wheat flour. Tapioca is sold in the form of dry flakes, pearls or sticks that must be hydrated beforehand before being consumed.

The applications of tapioca starch in the food industry are varied, but its most common uses are as a thickener in cake creams and sauces, in the manufacture of biscuits to improve texture, in the manufacture of gluten-free bread, and in baby food. Cinnamon (*Cinnamomum zeylanicum*) is a spice mainly obtained from cinnamon bark and leaves. It is an evergreen tree belonging to the *Lauraceae* family. The most recognizable species are *Cinnamomum cassia* (L.) J. Presl, *Cinnamomum camphora*, and

Cinnamomum zeylanicum. This plant has been known in several cultures for centuries, mostly in culinary applications. Cinnamon is popular for its aroma. It is incorporated in the aroma composition of perfumes [16]. Cinnamon has antioxidant compounds: polyphenols, phenolic acid and flavonoids give the health benefits for cinnamon as antioxidants, and prevent oxidative stress in the body by its response to free radicals and reduce damage from metabolic diseases in the body [17].

Many antioxidants that have been indicated in cinnamon: camphene, eugenol, salicylic acid, and epicatechin. In contemporary time, natural antioxidants are the concentrate of major interesting different studies that indicated it's effected. and fixed how it can be used there as effective foods and can block oxidative damage in the organism [18]. To carry out this study, we used skimmed cow's milk from an organic farm near Reghin city. The protein milk was obtained at the laboratory level as follows: the milk was pasteurized, then it was subjected to the concentration operation, which was carried out in a stainless-steel vessel with double walls, under laboratory conditions, until 1/3 was removed parts of water, so that at the end of the operation the protein content was 5.6. The content was determined by the protein titer determination method.

From the hyper-protein milk obtained, three varieties were made, symbolized as follows:

- LPM- hyper-protein milk: control sample;
- LPT- hyper-protein milk with the addition of tapioca, in the amount of 10 grams per 150 grams of protein milk;
- LPTS- hyper-protein milk with the addition of tapioca, in the amount of 10 grams and 2 grams of cinnamon per 150 grams of protein milk.

The samples obtained were kept at a temperature of 4-60 C, and were analyzed from a sensory and physico-chemical point of view at 1 day, 7 days and 14 days.

2.2. Methods of analysis

To control pasteurization [19], the amylase test was used, because amylase, which has the property of hydrolyzing starch, turning it into maltose, which must be treated with iodine iodide, no longer gives the characteristic blue color to milk heated above 63°C, so if pasteurization is corresponding, the absence of amylase, the content of the test tube turns blue-

grey or blue; improper pasteurization and unheated milk at a temperature of 63°C, the starch has been hydrolyzed, indicates the presence of amylase, when the mixture in the test tube turns citrine-yellow. Sensory analysis is the only method used to assess the quality of pasteurized drinking milk. All 3 samples were subjected to sensory analysis, and each sample was analyzed separately by 5 tasters. The method proposed for the sensory analysis was the scoring method with a small number of points, the ranking method, and the assessed sensory characteristics were: color, external appearance and consistency, taste and smell [20].

Acidity is realized by Thörner method which consists in neutralization of acids from a certain quantity of milk through titration with a solution of NaOH 0.1n, in the presence of phenolphthalein as indicator [20]. The pH was measured directly with a pH meter DM Orion 2 Stars at room temperature. Determining the total number of germs allows the assessment of the degree of contamination of the product, by sowing on media and counting the colonies [20].

3. Results and discussions

3.1. Pasteurization control – amylase test

Use The control of low pasteurization is very important to obtain a drinking milk of superior quality, it was performed only after the

pasteurization process to see the observance of the pasteurization regime, i.e., 72°C for 20 seconds.

The results obtained during pasteurization control for the three samples are presented in the following table:

Table 1. The result of the pasteurization control

No.crt.	Milk sample	Control reaction of pasteurization
1.	LPM	negative
2.	LPT	negative
3.	LPTS	negative

From the presented results, the pasteurization control reaction is negative for all three analyzed samples, respecting the pasteurization parameters.

3.2. Sensory analysis

The results obtained during the sensory analysis by the tasters are presented in the following figures:

• Appearance

The results obtained for the appearance characteristic are presented in the following figure:

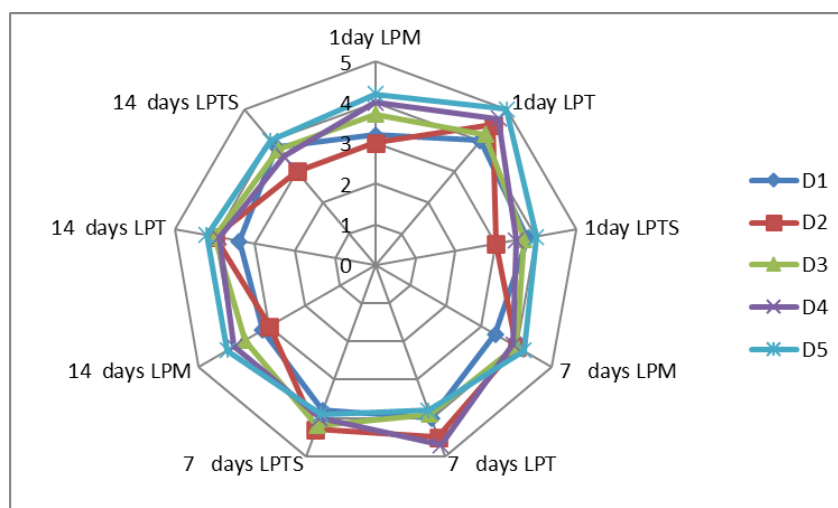


Fig. 1. The evolution of the appearance during the analyzed period

From the results presented, it can be seen that the tasters appreciated the appearance depending on the ingredients used to obtain these products, because they have an influence on this characteristic. The points awarded are higher on

the first day, for each assortment, after which they decrease on the seventh day.

• Consistency

The results obtained for the characteristic-consistency are presented in figure no. 2:

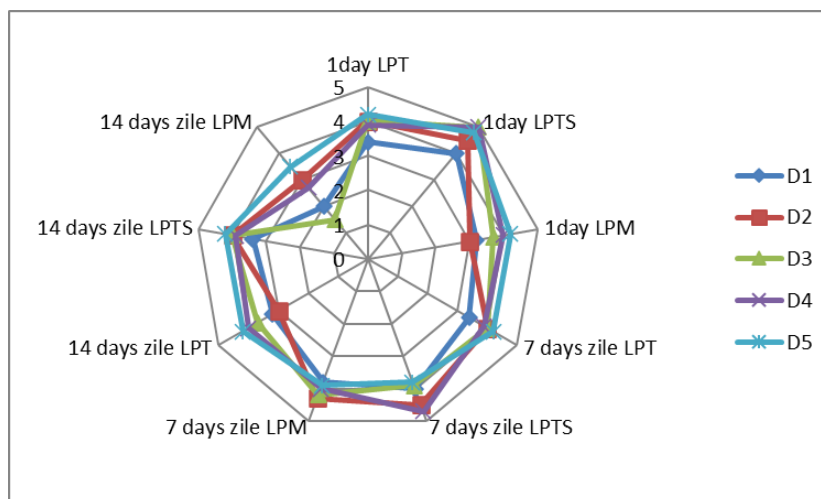


Fig. 2. Evolution of consistency over the analyzed period

From this graph it can be seen that the consistency also changes over the analyzed period, being influenced by the ingredients used. The LPTS sample received the highest scores, followed by LPT and LPM.

• **Smell**

The results obtained for the smell characteristic are presented in the following figure:

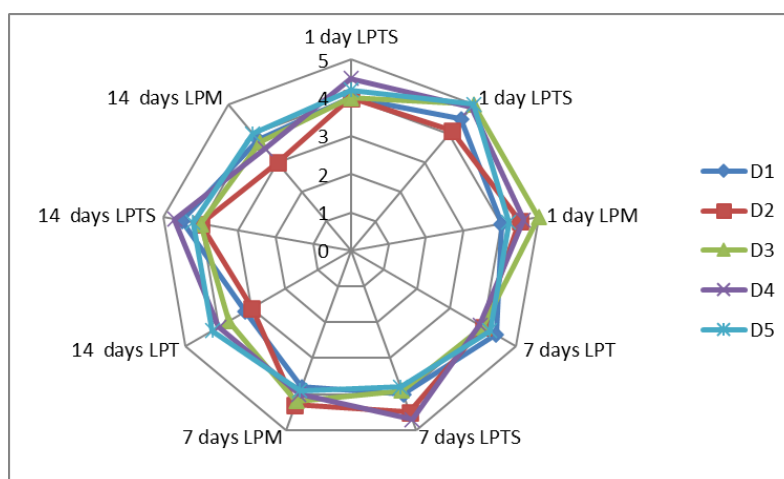


Fig. 3. The evolution of the smell during the analyzed period

From the results obtained, the LPTS sample received the highest scores over the entire analyzed period compared to the other two varieties due to the cinnamon content that gave it

a pleasant aroma, being followed by the LPM sample.

• **Color**

The results obtained for the characteristic-color are presented in figure no. 4:

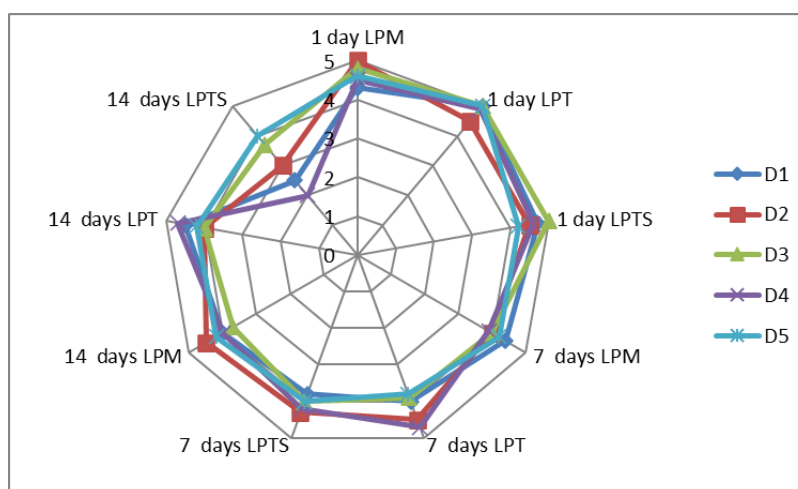


Fig. 4 Color evolution during the analyzed period

The graph shows that in the first two analyzed periods, all three types of milk analyzed received high scores from the tasters, which indicates that the color has been preserved, and on the last day the scores given are lower, because this characteristic started to modify. This

result is of particular importance in establishing the term of validity.

- **Taste**

The results obtained for the taste characteristic are presented in the following figure:

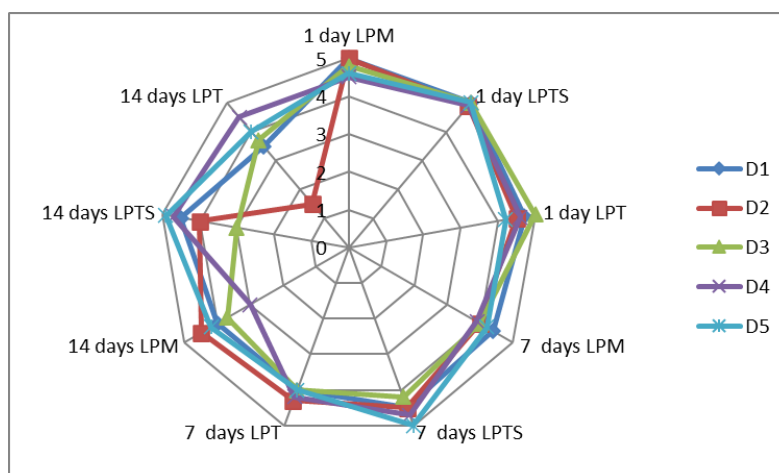


Fig. 5. Evolution of taste during the analyzed period

The taste is a characteristic that changes during the analyzed period, but on the first day the tasters gave high scores, which decreased towards the end of the analysis period. The LPTS sample received the highest scores throughout the analyzed period for taste due to cinnamon, which is an ingredient appreciated and used for a long time to obtain various products, followed by the

LPM sample, and the LPT sample obtained lower scores.

- **Determination of acidity by the Thorner method**

The results obtained when determining the acidity for the three samples are presented in the following graph:

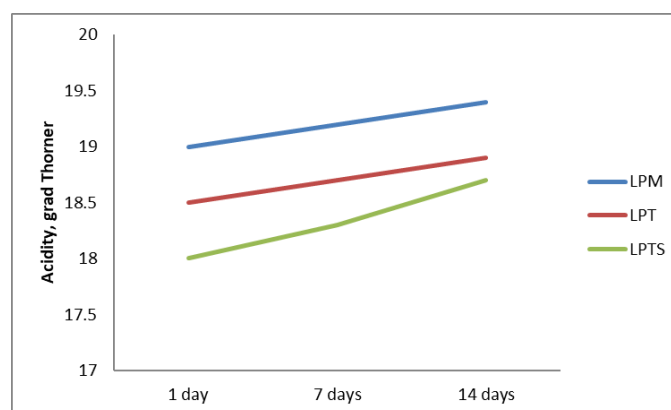


Fig. 6. Evolution of acidity over time

From the obtained results, it can be observed that the LPM sample shows a greater increase in acidity, and the other samples have lower values. According to the quality standards in force, drinking milk can have a maximum acidity of 21⁰T during the storage period. Hyper-protein milk, according to the quality standards in force,

can have a maximum acidity of 35⁰T during the storage period. We consider that the analyzed samples fall within the limits of admissibility,

▪ pH determination

The results obtained when determining the pH for the three samples are presented in graph no. 7.

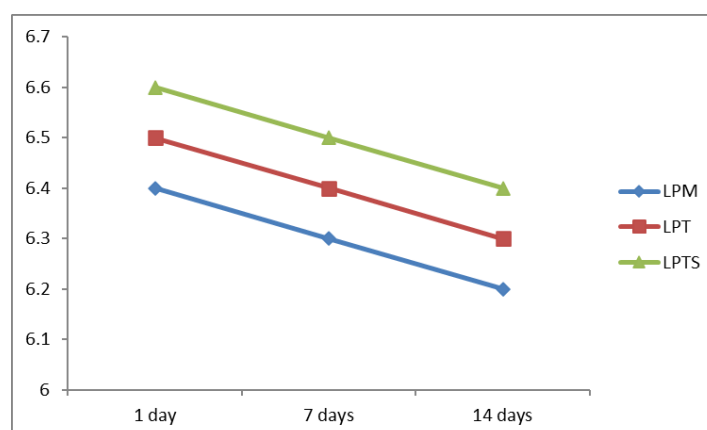


Fig. 7. Evolution of pH over time

From the obtained results, it can be observed that the Ph for the three analyzed samples has a corresponding evolution in the sense of its decrease, according to the increase in the acidity of the products, with the inclusion of the specified values in the quality standards.

▪ Determination of the total number of germs

The results obtained when determining the total number of germs for the three samples are presented in the following figure:

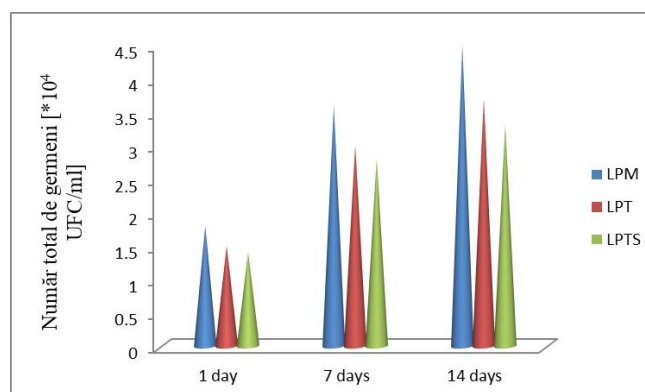


Fig. 8. Evolution of the total number of germs, NTG over time of the samples

From the graph it can be seen that LPM has a much higher increase in the total number of germs, compared to the other analyzed samples, on the other hand in the LPTS sample it can be observed that this increase is much smoother, because the addition of cinnamon also has an antimicrobial effect.

Conclusions

This approach to the implementation of a high-protein dairy product with the addition of a food supplement provides a diversification of the existing product range, but primarily provides support to consumers who want to improve their health and lifestyle.

Following the evaluation of the results and the analyzes carried out, the LPTS sample proves that it was highly appreciated in the sensory analysis due to the addition of cinnamon due to its special properties, and for the other analyzes it shows us that this innovative dairy product corresponds qualitatively to the analyzed period.

References

1. Usturoi, Marius, *Tehnologia laptelui și a produselor derivate*. Iași: Editura, Alfa, 2007;
2. Răducuță Ion, *Filierea laptelui*, Editura Universității Lucian Blaga din Sibiu, 2004;
3. Patton, S., *Milk: Its Remarkable Contribution to Human Health and Well-Being*. Taylor and Francis, pp.1-263, 2017;
4. Grunert, K., Furst, T., Connors, M., Bisogni, C., *Food quality and safety: consumer perception and demand*. *European Review of Agricultural Economics* 32930:369-391, 2000;
5. G.M. Costin, Rodica Segal, *Alimente pentru nutriție specială*, Editura Academica, 2001;
6. Drewnowski A., Popkin B.M., *The nutrition transition: New trends in the global diet*, *Nutrition Reviews*, 55 (2), 31-43, 1997;
7. Aral S., *Studies on functional foods in Japan-state of the art*. *Biosci. Biotech. Biochem.* 60, 9-15, 1996;
8. Feillet P., *Les priorites de la recherches sur les industries alimentaires*, *Ind.Alim. Agric.* 115, 12, 1998;
9. G.M. Costin, Rodica Segal, *Alimente pentru nutriție specială*, Editura Academica, 1999;
10. Costin G.M., *Alimente pentru utilizare nutrițională particulară*, *Buletin Inf. Ind. Laptelui* 15,3,14, 2000;
11. Breuninger, W. F., Piyachomkwan, K., & Sriroth, K. (12). *Tapioca/Cassava Starch*. Retrieved from https://www.researchgate.net/publication/279433516_TapiocaCassava_Starch, 2009;
12. Montagnac, J. A., Davis, C. R., & Tanumihardjo, S. A. (6). *Nutritional Value of Cassava for Use as a Staple Food and Recent Advances for Improvement*. Retrieved, 2009;
13. FAO. (2004). *Global cassava market study. Business opportunities for the use of cassava. Proceedings of the validation forum on the global cassava development strategy*, Vol. 6. Roma;
14. *International Starch Trading, Tapioca Food Starch*. Retrieved from <http://www.starch.dk/isi/applic/tapiocafood.htm>, 2003;
15. Adcox, M., & Olsen, N. (10,24). *6 nutrition facts about tapioca*. Retrieved from *Medica lNews Today*, 2019;
16. Rao, P.V.; Gan, S.H. *Cinnamon: A multifaceted medicinal plant*. *Evid. Based Complementary Altern. Med.* 2014,642942, 2014;
17. Abeysekera, Walimuni Prabhashini Kaushalya Mendis et al., “Antioxidant and Glycemic Regulatory Properties Potential of Different Maturity Stages of Leaf of Ceylon Cinnamon *Cinnamomum Zeylanicum* Blume) in Vitro.” *Evidence-based Complementary and Alternative Medicine*, 2019;
18. Mahdi, Montadher Ali, Mustafa Taha Mohammed, Abdulkadir Mohammed Noori Jassim, and Awatif I. Mohammed., “Phytochemical Content and Anti-Oxidant Activity of *Hylocereus undatus* and study of toxicity and the ability of wound treatment.” *Plant Archives* 18(2): 2672–80, 2018;
19. TIȚA Mihaela- Adriana, *Manual de analiză și controlul calității în industria laptelui*, Editura Universității “Lucian Blaga” din Sibiu, 2002;
20. ***Ministerul Agriculturii și Alimentației. *Colecție De Standarde De Stat Pentru Industria Laptelui*, Vol. 1. București: Cocpcia s.a., 1990.

ANIMALIA MOUNTAIN PRODUCTS, AS FUNCTIONAL FOOD. EVIDENCE FROM ROMANIAN AGRICULTURAL PRODUCTION

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Abstract: The paper presents experimental and statistical research carried out on products from the category of animal resources from the mountain area, especially those with the character of functional foods such as yogurt, kefir and sana. The purpose of analyzing these products resides in their qualitative, quantitative, territorial and agronomic development. The mountain area offers a healthier ecosystem than other areas, through the lens of a less polluted ecosystem. The soil is an important dimension in the realization of the mentioned animal products, but for higher quality results the entire ecosystem must meet certain standards, which is valid in the case of the mountain area. The paper presents experimental research carried out on the mentioned animal products, agronomic research on the traditional production of these products (traditional products are the best sellers), as well as statistical research on their distribution in the Romanian mountain area.

Keywords: Animalia fermented products, Animalia mountain products, functional food

1. Introduction

Among the analyzed products, kefir is the least known, especially in terms of its health benefits. Fermented dairy products (*Lactobacillus* spp., *Lactococcus* spp., *Streptococcus thermophilus*) - yogurt, sana, kefir, whipped milk, thick milk, sour milk, curdled milk, pasteurized milk - represent a very well-represented sector from the point of view of health, as well as from production and point of view.

Kefir is an element of Turkish cuisine, used extensively in South-West Asia, Asia Minor, South-East Europe and the Middle East. Kefir is a fermented drink traditionally made from cow's or goat's milk. It is obtained by adding fenugreek seeds to milk. These are not grains of grain, but grain-like colonies of yeast and lactic acid bacteria that resemble a cauliflower in appearance. Within about 24 hours, the microorganisms in the kefir grains multiply and ferment the sugars in the milk, turning it into kefir. Then the grains are removed from the liquid and can be used again. The lactic acid bacteria in the grains convert milk's lactose into

lactic acid, so kefir tastes sour like yogurt but has a thinner consistency. Kefir is more used than yogurt as a functional food because it can contain up to 61 different microorganisms, just as shown by Leite et al. [16]. Kefir is therefore a much stronger source of probiotics than many other fermented dairy products. Kefir presents numerous benefits on human and animal health, namely rich source of probiotics, has antibacterial properties, strengthens bones and reduces the risk of osteoporosis, prevents cancer, improves well-being, effective for various digestive problems [19].

According to the clinical studies presented and supplemented by the research within the paper, the consumption of yogurt present an affect on immunity, especially regarding leukocytes, average corpuscular hemoglobin, average concentration of hemoglobin/ erythrocytes, lymphocytes, monocytes, eosinophils and zinc [7-11].

Fermented dairy products have health benefits such as alleviating lactose and sugar intolerance. Consuming lactose, in the absence of lactase, leads to diarrhea, bloating, abdominal pain and flatulence. Cell-fermented lactates of *L.*

bulgaricus, *L. acidophilus*, *S. thermophilus*, and *B. bifidum* help consumers digest lactose. Fermented dairy products provide protection against gastrointestinal infections, have anticancer, antihypertensive, antiallergenic effects, stimulate the immune system, lower serum cholesterol and alleviate constipation [22]. Regarding the superior quality of the mountain products, European researchers believe that for *Animalia mountain products*, the key to higher nutritional values is the air-soil-water ecosystem, especially in the use of organic fertilizers. The main influence for the superior quality of mountain products provides less polluted water-air-soil-temperature ecosystems of the mountain area [20]. According to a study, organic fertilizers could represent a quantitative increase in potential of about 50%. Organic fertilizers improve poor and acid mountain soils, through organic matter and alkalinity, with minimal costs and the economic effect of maintaining floral structure and valuable biodiversity [7-11, 23].

A group of Spanish and Canadian researchers, interested in presenting the mountain product as a functional food with superior nutritional values, analyzed *Animalia dairy products* from the mountainous area of Spain compared to those from the plains. Their study captured the importance of the mountain area in ensuring exceptional quality for mountain dairies. The nutritional qualities of the fats in mountain and plain milk were compared.

The results confirmed the high quality of the mountain dairy products, in the conditions where no additional interventions were made, namely milk production in the plains. Fatty acid profile differences between mountain and valley milk samples were related to the nutritional content of botanical species under extensive grazing. However, supplementing the grass-based diet with concentrate in lowland farms increased the observed differences in milk fatty acid composition between lowland and upland farms. The approach of these authors was a spearhead in the research of the nutritional importance of mountain products. Research has shown that milk produced on mountain farms in northern Spain is much healthier than milk produced in lowland areas. Extending these results to the dairy sector could contribute to the added value of mountain products, including, for example, nutritional information on "mountain product" labels. The authors of this study believe that these results could be used to promote the commercialization of dairy products in mountain areas and at the

same time to contribute to rural development in the desert mountain areas of northern Spain and also in other European countries [6].

In a research on milk recovery, an exploratory analysis of consumer purchasing choices, carried out on 606 *Animalia mountain producers* in the Italian Alps, the authors were able to notice the high nutritional value of mountain products. It has been observed that individuals who emphasize the protection of their own health and the development of the local economy are more inclined to consume mountain products [5].

Several Austrian and Slovenian mountaineers conducted a qualitative research on local *Animalia mountain products*, studying the long supply chain, interviewing some farmers in the Austrian and Slovenian Alps. The mountain entrepreneurs who participated in the study emphasized that in order to ensure a good quality of the food product, in this case Tolminc cheese, several defining elements of the ecosystem are necessary, namely soil, meadows, precipitation, climate. The specific mountain soil in correlation with the composition of the grass, the higher rainfall with cooler climate and the shorter vegetation growth period lead to a mowing cycle of only two to three times. All these factors give the feed superior qualities. Another quality factor of the mountain dairy products studied in this research is the hygiene of the silo in the studied areas, this influentially defines cheese processing in the case of the Austrians/Slovenes. Other mountain entrepreneurs considered that the mountain product is of higher quality if the breeds used for production are better and the feed is in smaller quantities, i.e. less silage, less corn and more grazing. Milk produced in mountain farms at higher altitudes, with intensive grazing, is of superior quality to other types of milk. Some farmers emphasize the importance of microbiological quality of milk, hygiene, proper cooling and the absolute need for proper pasteurization [24].

Another study on mountain dairy products, carried out by a group of Italian and Danish professors, considered the preferences of educated consumers in the spirit of the nutritional quality of food. These consumers believe that mountain farms organized in a specific mountain way are producers of high quality *Animalia mountain milk*. The study also shows that the freedom of movement of farm animals (for example, not kept for a long time in stables), climatic and topographical conditions are important dimensions in ensuring the nutritional

quality of mountain products for Dutch, German or British consumers [27].

One of the important dimensions of mountain essential oils is its effectiveness in not spoiling food, a significant issue of human safety and security today. Researchers from Iran, Tunisia, Brazil, France, etc. correlates the use of mountain essential oils with the non-alteration of some *Animalia products*, namely dairy products [18], honey (*Apis mellifera products*) [1], beeswax [17], milk and cheese [26].

2. Materials and Methods

The paper presents experimental, statistical, agronomical, and territorial profile research.

The authors in some agricultural and food analysis laboratories have realized the experimental research. Macronutritional analysis have been realized at the ICA Research and Development, and by the companies in self-regime [13,14]. Author analysis processing presented in the paper reflects the information offered by SC ALS Life Sciences Romania SRL [4] for vitamins B12, D2, and D3, and by the National Institute of Research-Development for Animal Biology and Nutrition for iron Fe and calcium Ca [21]. For vitamin B12, the code of the method is B-VB12ELI01; for vitamin D2 and vitamin D3, the code is B-VDLCP02. Determination of vitamin B12 was realized through the ELISA method - RIDASCREEN FAST commercial set (made at ALS Czech Republic, accredited laboratory according to EN ISO IEC 17025) [4]. The determination of fat-soluble vitamins D2 and D3 was developed through two-dimensional liquid chromatography method with PDA detection (made at ALS Czech Republic, an accredited laboratory according to EN ISO IEC 17025) [4]. The determination of iron was realized through SR EN ISO 6869:2002 and STAS 9597/17-86, and calcium according to the complexonometric method add EDTA [21].

The statistical part of the paper consists in consulting the National Register of Mountain Products developed by the Romanian Mountain Area Agency and making an ordering of the products according to their functional role, respectively through the prism of being classified

as products of animal origin or products of vegetable origin. Later, the data were used to create graphics related to mountain products or the territorial profile map regarding the mountain producers of fermented dairy products. The map was created with the paintmap.com software.

The agronomic research was exploratory and applied. The specialized literature related to fermented dairy products was studied and the best solution was found for the production of fermented dairy products in the traditional system. The producers learned to apply this method. The traditional procedure applied by the studied mountain producers involves the successive inoculations of the initial starter cultures (prepared the previous day), *S. thermophilus* and *L. Bulgaricus*. Then, the mountain producers incubate in bulk until firm coagulation occurs or incubate overnight at room temperature.

This way of making fermented dairy products has drawbacks, such as acidification of fermented milk (with unwanted effects, for example whey syneresis), lack of control over the level of lactic acid produced during manufacturing. But the higher profits resulting from the sale of traditional fermented dairy products at higher prices than for the others encourage mountain producers not to give up this method. The increase in the productivity of these companies was observed against the background of increasingly high demand for fermented dairy products manufactured in the traditional system.

3. Results and Discussion

The mountain animal products taken into account for the macronutritional analyzes in the paper are from the category of fermented dairy products, respectively Yoghurt ADO 2.8%, Yogurt Gordon 2.8%, Yogurt Ibanesti 3.6%, Yogurt ADO 10%, Yogurt Ibanesti 10%, Sana Gordon 3.6%, Sana Ibanesti 3.6%, Kefir ADO 3.3%, Kefir Gordon 3.5%, Kefir Ibanesti 3.3% (table 1). The ADO brand belongs to the Western Region of Romania, and Gordon and Ibanesti to the Central Region of Romania.

Table 1. Macronutrient information for fermented mountain products

Nutritional information/ 100 g	Energetic value	Lipids	Fats	- Saturated fatty acids	Carbo hydrates	- Sugars	Proteins
Yoghurt ADO 2.8%	237kJ/ 57kcal	2.8g	-	-	4.6g		3.3g
Yogurt Gordon 2.8%	227kJ/ 54kcal	-	2.8g	1.86g	4.05g	2.29g	3.2g

<i>Yogurt Ibanesti 3.6%</i>	258kJ/ 62kcal	-	3.6g	2.5g	4.2g	4.2g	3.1g
<i>Yogurt ADO 10%</i>	508kJ/ 122kcal	10g	-	-	4.6g		3.3g
<i>Yogurt Ibanesti 10%</i>	532kJ/ 128kcal	-	10g	6.7g	4.5g	4.5g	5g
<i>Sana Gordon 3.6%</i>	275kJ/ 66kcal	-	3.6g	2.41g	4.62g	2.39g	3.75g
<i>Sana Ibanesti 3.6%</i>	258kJ/ 62Kcal	-	3.6g	2.5g	4.2g	4.2g	3.1g
<i>Kefir ADO 3.3%</i>	261kJ/ 63kcal	3.3%	-	-	4.6%		3.6%
<i>Kefir Gordon 3.5%</i>	275kJ/ 66kcal	-	3.50g	2.27g	4.93g	2.82g	3.65%
<i>Kefir Ibanesti 3.3%</i>	241kJ/ 58kcal	-	3.3g	2.1g	4g	4g	3g

Source: Authors according to ICA Research and Development and farmers' information [13-14]

Carbohydrates, which ensure the highest daily intake of energy, must be approximately 67 g, the ADO mountain products ensuring this requirement. The Ibanesti and ADO mountain products, considered in the research, also meet the other nutritional requirements related to functional foods with high probiotic effects (fermented milk products).

The information presented about Gordon's mountain products complies with the standard rigors for a product with natural probiotic effects. The micronutritional analyzes related to the fermented dairy products belong to the individual producer Amarinei Ovidiu from the North-Eastern Region of Romania (table 2).

Table 2. *Micro-nutritional information: fermented milk mountain product Amarinei O.*

<i>Nutritional information</i>	<i>Author analysis</i>	<i>USDA values</i>
<i>Vitamin B12</i>	0.690 µg/100g	0.560 µg/100g
<i>Vitamin D2</i>	12.5 µg/kg	0.025 µg
<i>Vitamin D3</i>	12.5 µg/kg	0.025 µg
<i>Iron</i>	1.138mg/100g	0.08mg/100g
<i>Calcium</i>	0.96%: 960mg/100g	183 mg/100g

Source: Authors according to SC ALS Life Sciences Romania SRL for vitamins B12, D2, and D3, and National Research and Development Institute for Animal Biology and Nutrition and farmers information for Fe and Ca [4]

The different values between the yogurt produced in the Western Region of Romania (Ferma Denis ADO) and that produced in the Central Region of Romania (Gordon Harghita and Ibanesti Mures) are given by the different ecosystems of these areas.

In the Romanian Center region, the relief favors this type of development, the soils being rich in humus and presenting the most fertile lands. The zonal soils with high fertile content are from the class of molisols, specific for the cultivation of cereals and technical plants, leached chernozems, argiloiluvial soils, brown and brown-acidic soils (cambisols), spodosols (podzols and mountain acid browns). The agriculture of the mountain area is predominantly based on pastures and natural hay. The forest fund of the region is very rich, giving the air-water-soil-temperature ecosystem high natural values. [12]

Different from the Center region of Romania, the West region of Romania has a climate temperate-continental with oceanic and sub-

Mediterranean accents, is one of the advantages of the western mountain area. Being a warmer area, mountain production is favored for a longer period than in other areas of Romania. Due to the abundant precipitation, the area is favorable for crops specific to wetlands. The hydrographic resources of the region support high-quality mountain production. The spontaneous flora of the region, with Central-European and Macaronesian-Mediterranean influences, is intensively exploited within the mountain-specific production-sales chain. The fauna presents a multitude of biotypes, many of the animal resources being used as support for mountain production. In the region, all classes of soils are present, relevance for mountain production being clayey, cambisols, spodosols, molisols and hydromorphic soils. Agricultural areas have high potential for regional and national mountain production. [12]

In the Harghita Mountains – Center region – the soils are brown acid, podzolic and feralluvial, favoring water retention influencing

the flora which presupposes the existence of St. John's wort meadows (*Hypericum maculatum*), woody species, wind grass (*Agrostis rupestris*), red sedge (*Festuca rubra*), blueberry (*Vaccinium myrtillus*), raspberry (*Rubus idaeus*), peat bogs. This flora influences the production of fauna, especially the milk of cows and sheep produced in the area. In the Retezat Mountains, Hunedoara side – the West region – the soils are brown (non-acidic), reddish-brown, which are weakly associated with chernozems. These soils are more productive than those in the Harghita Mountains, the flora - more aromatic - is composed of soursop (*Barbarea vulgaris*), mountain peony (*Rhododendron myrtifolium*), saffron (*Crocus banaticus*), plantain (*Plantago gentianoides*). Fauna production is richer in fat, the results being associated with cow's and sheep's milk richer in protein than that of the Haghita area. [7-11]

The authors propose in the paper some solution for agronomic production of the fermented products. Agronomic and territorial

landmarks of the Romanian producers of mountain products and producers with the role of functional food from the dairy sub-sector of the animal sector, show that a mountain area properly exploited can offer more productivity and quality.

The animal sector of mountain products, the fermented dairy sub-sector, territorially covers the development regions of Romania. Honey, raw milk, fermented dairy products, cheeses, raw meat and sausages are the most common mountain products nationally [3].

Mountain producers belonging to the fermented dairy classes are mainly produced in Harghita, Covasna, Hunedoara, Braşov, Suceava (fig.1) [2].

The production of fermented dairy products is approached in this work through the traditional prism, being the most delivered by mountain producers and the most sought after by consumers of mountain products on the Romanian market.



Fig. 1. Territorial profile of Romanian mountain producers of fermented milk

Source: Authors according to ANZM

Fermented dairy products have relatively similar traditional processing methods, which is why the approach will be carried out for the standard product – yogurt. Traditionally, the presented producers made yogurt from boiled milk that is concentrated to two-thirds of the original volume. Afterwards the milk cools down to the incubation temperature (optimal – the

temperature of human blood). The mountain producers analyzed in the paper also use the traditional method of dairy production, the profits convincing them to continue its application [25].

The Romanian market for fermented dairy products (Yoghurt; whey, coagulated milk and cream, kefir and other fermented or acidulated dairy products and cream, whether or not

concentrated or with added sugar or other sweeteners or flavored or with added fruit, nuts or cocoa) is moderately represented in exports, showing an annual increase in the period 2017-2021, of 15% for Yogurt, whether or not flavored or with added sugar or other sweeteners, fruit, nuts or cocoa - with a value volume in 2021 of 50428000 \$, and 38% for Whey and coagulated, fermented or acidified milk or cream, other, concentrated or not, sweetened or with added fruit, nuts or cocoa - with a value volume in 2021 of \$6118000 [15].

Conclusions

Presented results - experimental, statistical, agronomical, and territorial profile - show that Animalia mountain products could become more competitive, especially for the functional food necessary in the pandemic.

The ecosystem of the flora from which the yogurt originates is favorable for the production of high-quality milk, with the possibility of development. Proposed remedial mountain agronomy is that for a stronger influence on health, the authors propose to continue and intensify the use of the traditional method of making yogurt.

The results show that mountain products from fauna that had access to a richer and more aromatic flora are tastier and healthier than the others. The paper demonstrates that the analyzed mountain products sustain the development of the energetic value, protein, lipids, sugars, carbohydrates, fats, calcium, iron, B12 and D. Also, the analyzed fermented mountain products are better than other products (USDA standards).

The ADO and Gordon mountain products considered in the research also meet the nutritional requirements related to high-quality probiotic (fermented dairy) functional foods.

The public and private governance could understand and apply policies dedicated to the mountain area, so the investments could increase to develop a good mountain value chain.

References

1. Abdelkader H. B., Boussaada O., Saidana D., Chraif I., Mahjoub M.A., Helal A.N., and Mighri Z. Variability in Volatile Fractions Composition of Tunisian Honey. *Journal of Essential Oil Bearing Plants* 114, 2008, p. 328-334;
2. Agenția Națională a Zonei Montane din România - ANZM. *Registrul Național al*
3. *Produselor Montane din România RNPM*, 2002;
4. Agenția Națională a Zonei Montane din România - ANZM. *Registrul Național al Produselor Montane din România RNPM*, 2023;
5. ALS Life Sciences SRL. *Analize micronutriționale vitaminele B12, D2 și D3 pentru miere de albine, usturoi și iaurt*, 2023;
6. Bentivoglio D., Bucci G., and Staffolani G. Valorizzazione del latte Prodotta di montagna: un'analisi esplorativa sulle scelte di acquisto dei consumatori. *Rivista di Economia Agraria* 752, 2020, p. 77-89;
7. Bravo-Lamas L., Aldai N., Kramer J. K., Barron L. J. R. Case study using commercial dairy sheep flocks: Comparison of the fat nutritional quality of milk produced in mountain and valley farms, *LWT* 89, 2018, p. 374-380;
8. Covaci, B., and Covaci, M. Mountain food as a natural probiotic: Evidence from Central and Eastern European nutrition and. *International Food Research Journal* 30(1), 2023;
9. Covaci, B., Brejea, R., and Covaci, M. Sweeteners World Trade and Behaviour in the Pandemic. Evidence from Honey Remedies Nexus Mountain Apis Mellifera Product. *Sugar Tech*, 2023, p. 1-12;
10. Covaci, B. et al. *Annual research report Mountain entrepreneurship for the sustainable development of the mountainous area in Romania*, Mountain Economy Center of the Romanian Academy - NIER, 2022;
11. Covaci, B. et al. *Annual research report Mountain entrepreneurship, support for the development of mountain areas in Europe. Case study on mountain entrepreneurs in Romania*, Mountain Economy Center of the Romanian Academy - NIER, 2021;
12. Covaci Sterpu, B. *Contribution of the Reports and dissertation of doctoral research*. Oradea University, 2020-2023;
13. Horticultura Bucuresti. *Pedologie*, Universitatea de Stiinte Agronomice si Veterinare din Bucuresti, <https://www.horticultura-bucuresti.ro/images/pdf/Pedologia.pdf>;
14. ICA Research and Development. *Informații nutriționale raport nr. 8214601*, 2021a;
15. ICA Research and Development. *Informații nutriționale raport nr. 8214602*, 2021b;
16. International Trade Center ITC. *Comerțul bilateral al României cu țările lumii pentru diverse produse*. Trade Map, 2022;
17. Leite A. M. D. O., Miguel M. A. L., Peixoto R. S., Rosado A. S., Silva J. T., and Paschoalin V. M. F. Microbiological, technological and therapeutic properties of kefir: a natural probiotic beverage. *Brazilian journal of microbiology* 44, 2013, p.341-349;

17. Leonardo Lomele R., Miyuki Ito M., and Oliveira Orsi R. Essential Oils in Beeswax Production by *Apis mellifera*. *Journal of Essential Oil-Bearing Plants* 197, 2016, p. 1826;
18. Mahmoudi R., Zare P., and Nosratpour S. Application of *Teucrium polium* essential oil and *Lactobacillus casei* in yoghurt. *Journal of Essential Oil-Bearing Plants* 182, 2015, 477-481;
19. Marin C. *Chefirul: băutura magică pentru o digestie sănătoasă*, 2023
<https://www.doc.ro/dieta-si-sport/chefirul-bautura-magica-pentru-o-digestie-sanatoasa;>
20. Mancaş S., Mihaş G., Duda-Seiman D. M., Sarău C. A., and Noveanu L. *Activitatea fizică şi cardiologia preventivă modernă. Secţiunea: Siguranţa alimentului în contextul sistemului HACCP şi calitatea alimentaţiei*, 85, 2005;
21. National Institute of Research-Development for Biology and Animal Nutrition - IBNA, 2023. Micronutritional analysis of iron and calcium for honey, garlic and yogurt (no. 42/11.04.2023);
22. Parmjit S. Fermented dairy products: starter cultures and potential nutritional benefits. *Food and Nutrition Sciences* 201, 2011;
23. Rey R. 'Mountain Product', of High-biological Quality. Meadows' Poliflora, Organic Fertilizer and a Sustainable Mountain Economy. *Procedia Economics and Finance* 8, 2014, p. 622-631;
24. Schermer M., Matscher A., and Borec A. *The perception of quality aspects for mountain products in long supply chains-Cases from Slovenia and Austria*. In: Mountain food products: A special system of provision, Proceeding of the 9th European IFSA Symposium 4-7, Wien, Austria, July 2010;
25. Tamime A. Y., and Deeth H. C. Yogurt: technology and biochemistry. *Journal of food protection* 4312, 1980, p. 939-977;
26. Tornambé, G., Cornu, A., Verdier-Metz, I., Pradel, P., Kondjoyan, N., Figueredo, G., Hulin, S., Martin, B. Addition of pasture plant essential oil in milk: influence on chemical and sensory properties of milk and cheese. *Journal of Dairy Science* 911, 2008, p. 58-69;
27. Zuliani A., Esbjerg L., Grunert K. G., and Bovolenta S. Animal welfare and mountain products from traditional dairy farms: How do consumers perceive complexity? *Animals* 811, 2018, p. 207.

THE ADAPTION OF GREEN PURCHASING AS A TOP MANAGEMENT COMMITMENT TO DEPEND ON THEIR SUPPLIER'S COLLABORATION - SUPPLIER EVALUATION SYSTEM AS A CASE STUDY

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Abstract: In this case study, an effective supplier evaluation process was used by Schaeffler with the involvement of the environmental and social criteria to a different extent with respect to the main criteria of the quality, cost, and time to green their products and reduce the waste in line with the suppliers' involvement to deal with the different regulations and challenges. Different approaches were applied to achieve sustainability by applying social and environmental criteria in the supplier evaluation as a prequalification of the suppliers. However, an analysis of the supplier evaluation system was done for Schaeffler to figure out how did they implement sustainability in their supplier evaluation system which agrees with what been mentioned in the literature about the importance of the supplier evaluation as one of the most effective and critical approaches that must be involved in the development process of the organization.

Keywords: green purchasing, supplier evaluation system

1. Introduction

Following the dominance of linear economy (Take-Make-Dispose), a new economic paradigm (Circular Economy) emerged as a systemic solution aimed at minimizing waste and continuously using resources by reuse, repair, refurbishment, remanufacture, and recycling, thus ensuring the minimization of input resources and eliminating waste. There was a need to develop circular structures to ensure the health of our planet, which integrates the circular economy concept to minimize environmental pressure while increasing competitiveness, creativity, and profit. Circular economy (CE) is currently widely promoted by several national governments as well as by several businesses around the world [1].

The current inefficient use of resources is calculated to cost the European industry 600 billion euros annually. These can be translated into substantial gains by increasing the resource efficiency in manufacturing [2]. Organizations cannot neglect environmental concerns if they want to succeed in the global market. As government regulations and public concern about environmental sustainability have grown, integrating environmental, economic, and social

success to achieve long-term growth has emerged as a major business challenge in the twenty-first century [3].

Moving toward the CE would necessitate a paradigm shift in the manufacturing process, with sustainability and closed-loop thinking at the forefront of business models and industrial organizations [4]. An effective transition to a circular economy is dependent not only on available skills and competencies but also on the skills and competencies needed in a circular labour market.

To adopt CE principles, businesses must make significant upfront investments and rely on their vendors and retailers to cooperate since all supply chain partners must be involved [5]. Supplier choices are among the most important things companies must integrate into their strategic processes. Supplier management decisions have become more strategic as the buying function has become complex. Bad decision-making's direct and indirect effects become more important as companies become more reliant on suppliers [6].

To ensure more reliable and environmentally friendly production, the manufacturing industry should modernize supplier assessment processes and include greener production indices, such as

resource usage and applicable qualification approval, into supplier management [7].

2. Literature review

The idea of a circular economy is based on industrial ecology, which envisions a type of material symbiosis between companies and production processes that are otherwise very different. In industrial ecology, the advantages of recycling residual waste materials and by-products are emphasized, with the implication that a circular economy would support society and the economy. Benefits can be realized not only by reducing the use of the atmosphere as a residual drain but also – and perhaps more importantly – by reducing the use of virgin materials for economic activity. The potential benefits seem straightforward at first glance, but it is important to note that the circular economy approach is based on physical rather than economic considerations [8].

The circular economy has a linguistic as well as a descriptive sense, it is the antonym of a linear economy in linguistic terms. A linear economy is one in which natural resources are converted into waste by processing which will cause harm to the ecosystem in two ways: by removing natural capital from the ecosystem (through mining/unsustainable harvesting) and lowering the value of natural capital due to waste pollution which may also occur during the acquisition of resources. A circular economy has no net impact on the environment; rather, it recovers any harm caused during resource acquisition while ensuring that little waste is produced during manufacturing and throughout the product's life cycle.

A second, inferred, descriptive sense of the word circular is related to the idea of the cycle, two processes are particularly important here: biogeochemical cycles and the concept of product recycling [9].

The root of the word "Circular Economy" is a point of contention. Certainly, the concept of a circular economy has been around for quite some time. Hoffman, the first president of the Royal Society of Chemistry, claimed in 1848 that "in an ideal chemical factory there is, strictly speaking, no waste. The better a real factory uses its waste, the closer it gets to its ideal, the bigger the profit" [10]. Another claim is that Kenneth Boulding (1966) was the originator of the term when he wrote: "Man must find his place in a cyclical ecological system which is capable of continuous

reproduction of material form even though it cannot escape having inputs of energy" [11]. It was originally a Chinese term, according to Liu et al. (2009) [12].

According to Yuan et al. (2006), the first use of the circular economy concept was in China, in an unreferenced 1998 paper by Zhu, which was influenced by German and Swedish loop-closing and arose from the Industrial Ecology paradigm, which models industrial processes using the flow of material and energy through them. The inclusion of Sweden here is noteworthy, as most literature credits the inspirations to Germany and Japan [13].

Most of the related literature is published in scope documents and initiatives from governments and nongovernmental organizations, indicating that the CE definition is currently being developed in Europe. The development of concepts, the production of visions, and the formulation of strategies are all addressed in these publications [14].

Since it has been considered one of the effective and essential roles of purchasing managers, supplier assessment and selection have received a lot of coverage in the literature. Reduced buying risk and the establishment of close, long-term partnerships with suppliers are among the goals [15]. Cost, delivery time, and quality are the most significant supplier performance characteristics that are considered during the assessment process [16]. Supplier assessment, according to Lasch and Janker (2005), is a multi-level method suitable for launching a new product [17].

Banker (1995) described the supplier evaluation process as an important decision field in operations management [18]. Due to the exponential transition and growth in the modern sector, and to reduce carbon footprints and implement more eco-sustainable processes, the supplier selection process cannot be solely dependent on these three factors, and other relevant aspects must be included in the decision-making process.

Companies are kept liable not only for their internal activities, but also for the actions of their vendors [19]. Due to environmental and social issues with manufacturers, as well as regulatory demands and legislation, consumer demands, stakeholder reactions, and pressure from governmental and non-governmental organizations, they have used sustainability requirements in their supplier assessment. Companies are gradually considering

sustainability when implementing supplier appraisal schemes that have environmental and social requirements [20].

Pre-qualification of suppliers must be considered, in which suitable suppliers must be identified and restricted to a certain amount by gathering information about them, which is then supplemented by an inspection of the supplier based on the information collected. In addition, supplier evaluations are performed, in which vendors are visited to ensure that they fulfill all of the relevant specifications. A comprehensive and thorough assessment of the supplier is needed to pick or monitor a supplier. Supplier procurement relates to evaluating and selecting a new supplier, while supplier monitoring is concerned with reviewing existing suppliers' results [17]. Supplier assessment takes place during the pre-selection of suppliers, the selection of a single supplier for an order, and supplier management.

Companies can use a variety of screening tools to choose the right suppliers [21]. Standard methods for supplier assessment include weighted-point systems, categorical systems, and/or cost-based systems. While categorical and weighted point systems assess a supplier's efficiency based on a variety of metrics, cost-based systems are mostly concerned with a supplier's overall cost [22]. Furthermore, the checklist form [17], as are "knock-out" parameters, is also used. To analyze and pick suppliers, a recent emphasis in the literature has been on multi-criteria decision-making methods such as the analytical hierarchy process, analytical network process, or data envelopment analysis [23].

Suppliers are often active in the new product creation process, according to several studies, because (i) they also have design and technological experience, and (ii) the reliability of their operating method has a significant effect on the final product production [24]. Despite the increasing importance of suppliers in the NPD phase, neither current literature nor company experiences indicate models for supplier selection that effectively consider environmental efficiency [25], since suppliers' environmental performance influences purchasers' environmental performance.

Manufacturing and service companies will lessen their overall environmental effects in two ways [26]:

1. by rising the amount of money invested in green technology.

2. by reinvesting in pollution reduction rather than pollution control.

Surprisingly, many businesses concentrate their efforts mostly on their own production operations and distribution networks. Despite this universal awareness, businesses have recently begun to participate in green procurement extending the upstream supply chain, recognizing that addressing the sustainability issue would require a concentrated effort [27].

As a result, presenting a scientific and accurate assessment scheme and process for green supplier selection is a critical challenge with real-world implications [28]. According to studies, companies that take a positive approach to environmental problems will lower prices and improve consumer demand. Easy processes such as limiting access to computer printers, using double-sided photocopying, and operating on electronic records, for example, have been shown to save money while still improving workflow efficiency.

3. Methodology

A case study is adopted to analyze the supplier evaluation and selection process for a company in the automotive industry to understand the process of implementing the green ideas of the Circular Economy into the supplier evaluation and selection procedure and how that helps to reach the target of sustainability and how does it affect the competitiveness and the position of these companies in the world market.

A case study is a research tool that aids in comprehending the complexities that exist within a particular environment [29]. According to Simons (2009), a case study is an in-depth examination of the complexity and uniqueness of a single project, strategy, organization, program, or method in a "real-life" context from multiple viewpoints [30]. Thomas (2011) described the case study as a holistic examination of people, activities, decisions, times, projects, strategies, organizations, or other processes using one or more approaches. The investigation's case would be an example of a class of phenomenon that offers an explanatory framework - an entity-within which the investigation is carried out and which the case illuminates [31].

The strengths of the case study methodology are identified by I. Benbasat et al., (1987) as [32]:

- i. "It provides an opportunity to study the phenomenon in its natural settings, understanding

and observing the actual practice which helps to generate a meaningful a relevant theory.”

ii. “It allows the much more meaningful question of why rather than just what and how.”

iii. “It helps to perform early exploratory investigations where variables are still unknown.”

Schaeffler Group is a genuinely global leader in rolling part bearings for automotive, aerospace, and industrial applications. Schaeffler Group contributes to the achievement of sustainable development priorities by understanding the emerging market climate and focusing on the supplier assessment process; With a range of activities and product options, the UN's 17 Sustainable Development Goals are intended to help ensure sustainable development on an economic, social, and ecological basis. Schaeffler Group is committed to the Global Compact's values and is motivated by the National Action Plan for Business and Human Rights, the UK Modern Slavery Act, the German Sustainability Strategy, and the Paris Climate Change Agreement's goals. As a result, Schaeffler Group has set a target for itself to save 360,000 tons of CO₂ by 2025, relative to the baseline year of 2016. Schaeffler Group has 75 manufacturing facilities in 71 locations around the world, all of which have an ISO 14001-compliant environmental management scheme. Since December 31, 2017, 68 Schaeffler Group locations have been added to the European Union's EMAS domain list, five more than the previous year.

Furthermore, the group has ISO 14001 certification at 69 locations. However, in order to achieve the ambitious targets of the company, suppliers must be engaged. As a result, before integrating a supplier into its network of suppliers, Schaeffler group reviews their conformity with environmental and social norms,

as well as releasing the corporate supplier code of ethics as a binding principle of a contractual partnership to meet the group's assumption of long-term viability. The ethical and legal guidelines outlined in this Supplier Code of Conduct must be followed by all Schaeffler suppliers. Within the supply chain, the retailer can also cascade these conditions.

4. Analysis

Regarding the consideration of environmental and social issues and as a part of sustainable corporate leadership, Schaeffler has implemented different approaches led by the company's values of sustainable, innovative, excellent, and passionate for long-term profitable growth while assuming responsibility for the environment and society at the same time. These approaches are described to provide an overview of the applied criteria and the application of environmental and social issues in supplier evaluation is presented.

4.1. Supplier cooperation policies

Schaeffler are adopting the vision of including the suppliers in the responsibility of fulfilling the company's and customers' expectations about sustainability to ensure that the suppliers have safe working conditions and that their employees are treated respectfully. Also, to make sure that their production processes are responsible and environmentally friendly. Therefore, Schaefflers' new suppliers must sign the supplier code of conduct (SCoC) which is summarized in Table 1. In addition to the SCoC, on-site assessments are carried out as production tours during which questions are asked about original quality issues and production-related aspects of occupational safety and environmental protection.

Table 1. Suppliers' code of conduct (Source: [33])

Basic behavioral requirements	• Transparency, Trust and Teamwork • Compliance with applicable laws • Respect for human rights • Avoidance of conflicts of interest
Behavior towards business partners and third parties	• Integrity • Fair competition • Anti-corruption • Trade controls
Handling of information	• Protection of confidential information • Compliance with data protection guidelines

Treatment of employees	• Fair working conditions • Rejection of forced and child labor
Environment, Health, and Safety	• Acting sustainably • Safe working environment

4.2. Conflict materials

According to the EU Regulation 2017/821 of 17 May 2017 and along with the “Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains”, Schaeffler are guided by the worldwide requirements and guidelines regarding the sourcing of conflict minerals and have the aspiration that all their products are free of conflict minerals from conflict-affected and high-risk areas which systemically violate and goes against the human rights. The term “conflict minerals” is defined as 3TG - gold, tantalum, tin, tungsten, and any other mineral defined by regulations applicable to the sourcing of conflict minerals. Schaeffler is integrating the “OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas” into their processes to source these minerals. The suppliers are required to accept the conflict minerals policy and they are also expected to fulfill their due diligence obligations along the supply chain about conflict

minerals and to submit reports which will be used as a part of the pre-selection of the suppliers.

4.3. Communication, Information, and data exchange

To achieve efficient cooperation between the customer and the supplier and to accelerate the procedures of business processes of logistics, purchasing, quality, and finance. Schaeffler are using the shared online platform “SupplyOn” to make it easier for the suppliers to process all business transactions with their customers within one flexible central system in a secure manner. SupplyOn is a central interface on the internet that links the participating companies and their systems to each other to simplify the data exchange and speed up all the processes related to the supply chain. The supplier portal “SupplyOn” offers optimization in communication and availability, process automation, process quality, security, up-to-date accuracy, and options as shown in Table 2.

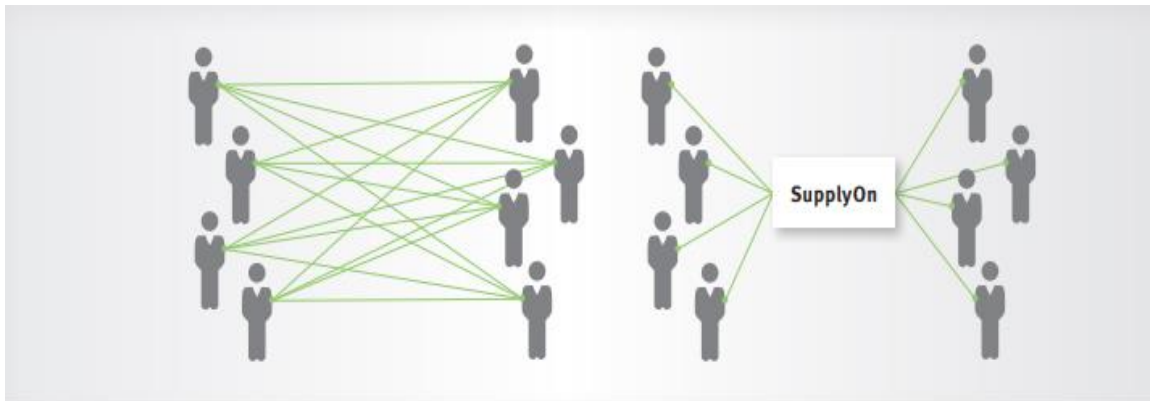


Fig. 1. “SupplyOn” communication network (Source: [34])

Table 2. The optimized situation of “SupplyOn” (Source: [35])

	Normal situation	The optimized situation
Communication & availability	Multiple communication channels between customers and suppliers.	One platform for several customers at the same time.
Process automation	Manually high costs activities in dealing with different costumers.	Data capturing in the system without communication disturbance
Process quality	Manual processes and multiple data inputs.	Providing data and information easily.
Security	Unsecured data movement.	High security to reach and share data.

Up-to-date accuracy	More work to gather information from different sources.	Continuous exchange of information with customers.
Options	Hard to find new business possibilities.	Updated business activities for customers.

The inferred advantages are summed up in the reduction of administrative costs by reduction of the repeated manual activities, which also have a high probability of errors, reliability in data exchange between the suppliers and customers with replacing multiple communication channels which has different availability conditions such

as fax, e-mails, and post into one platform with very high access security, continuous availability, and high reliability away from the industrial espionage. The portal also offers ease of access to new business possibilities from different customers.

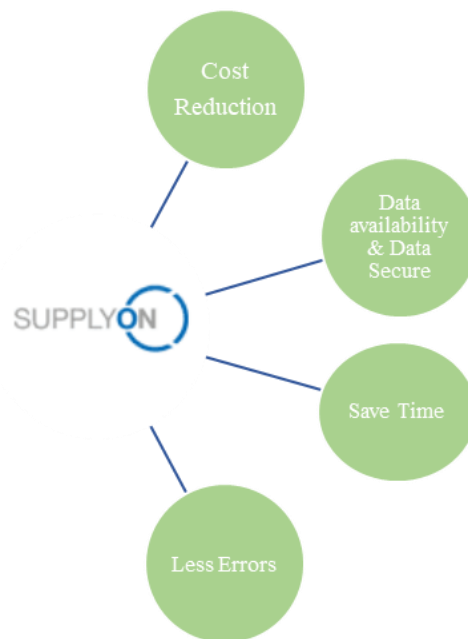


Fig. 2. Advantages of “SupplyOn” for suppliers (Source: authors' own editing)

SupplyOn provides potential improvements identification through the “performance monitor” which gives access to the suppliers to analyze their customers’ ratings in a standardized and structured form. The supplier ratings are continuously updated on the performance monitor from the participating buying company’s system. The suppliers can reach their ratings from different companies, and they use their own evaluation criteria easily in a unified and easy using system.

The performance monitor is counted as one of the management tools which allows for increasing competitiveness on a sustainable basis. It also benefits the suppliers by providing key performance figures and a differentiated view of the customers’ overall assessment of the services with high transparency regarding the actual quality status. The performance monitor data can give an identification of the possible area of

weakness based on various analysis options. Therefore, that confirms the concept of continuous improvements for the suppliers to keep up with the company’s future vision.

4.4. Supplier Evaluation

According to the international standard for automotive quality management (IATF 16949), which is a common automotive quality system requirement based on ISO 9001, and customer’s specific requirements from the automotive sector. One of the requirements for the IATF 16949 is the supplier evaluation which takes account of the requirements for this standard as the standard is a component of the quality management system.

The suppliers of Schaeffler are expected to introduce improvement measures and reports to show cooperation in the continuous improvement to minimize the risk by identifying the potential

risks related to the suppliers at an early stage and correcting them with suitable measures. Schaeffler's supplier evaluation uses a standardized evaluation criterion that assesses the quality and delivery performance of the suppliers on a regular basis. The adjustment based on the IATF 16949 comprises three sides:

- Quality
- Logistics
- Logistics-VMI (Vendor managed inventory)

As the quality of the products is a vital indicator of competitiveness and the position in the world market, Schaeffler is looking to achieve a good quality performance by the overall quality rating for their suppliers since they have a corresponding influence on the highly technical production facilities and on the quality of products.

The overall quality rating has an individual criterion consisting of a dynamic factor which is mainly used in the evaluation, and others are used as a devaluation criterion which can directly affect the overall rating of the suppliers.

The individual criteria are given as follows:

- **Quality performance:** For the quality rating the concept of "zero defect" is applied with the focus on dynamic individual criteria "number of complaints" and "ppm" with a higher weighting for the number of complaints with 75% influence to 25% to the ppm with overall 100% weighting in the evaluation system.
- **QM certificates and special status notification:** The weighting in the

evaluation system for these factors is 0%, but they are considered direct influencers and devaluation factors, which can lead to a downgrading in the overall supplier rating

- **Sample quality performance:** It's considered a separate criterion and independent evaluation which describes the experimental production process with 0% weighting in the evaluation system.
- **Sustainability and corporate responsibility:** It's considered a direct influencer and devaluation factor on the supplier rating. It consists of three individual criteria: environmental certificate, health and safety protection and supplier code of conduct. It also has a 0% weighting in the evaluation system.

The overall logistics rating consists of two individual criteria:

- Logistics delivery performance is valued in three key categories: date reliability, quantity reliability, and logistic complaints.
- Logistics-VMI rating: the evaluation of VMI is regularly evaluated by Schaeffler in relation to the performance of its suppliers to tie the suppliers more effectively in the stockholding industry. It's evaluated mainly based on two different weightings, 80% for the commitment to the agreed quantity targets and 20% based on the logistics complaints and quality defects.

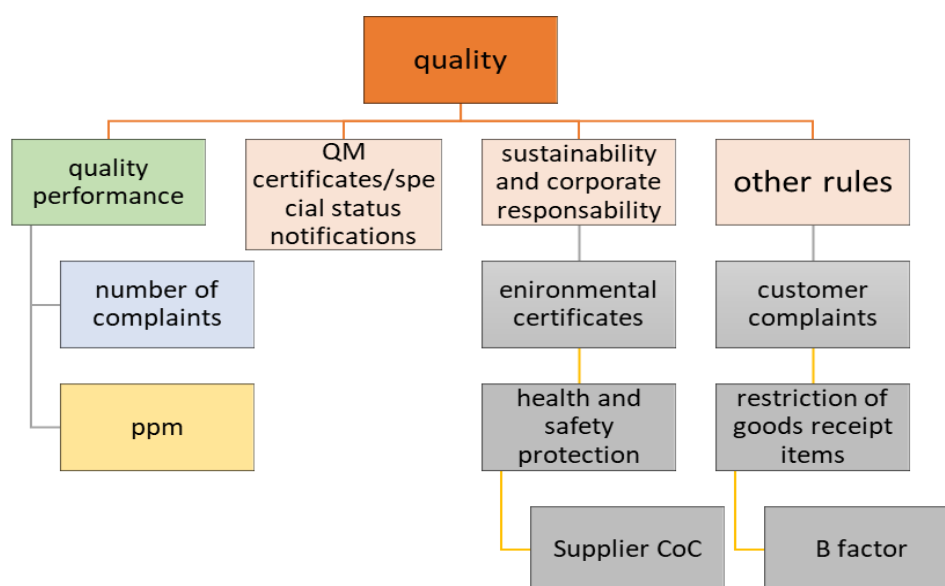


Fig. 3. Quality rating graphical representation (Source: authors' own editing)

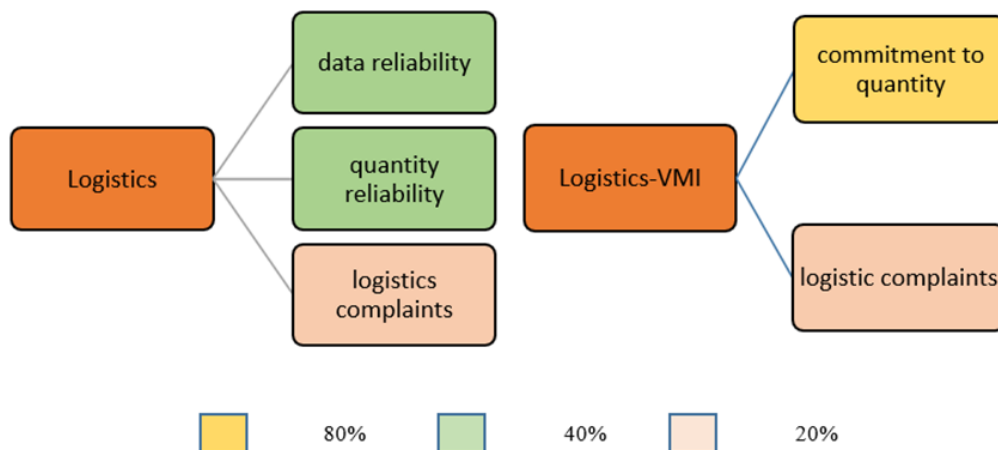


Fig. 4. Logistics/Logistics-VMI graphical representation (Source: authors' own editing)

The suppliers will receive their evaluation results through the performance monitor in SupplyOn monthly, which is considered by the Schaeffler group in all locations. The performance monitor enables the supplier to improve their performance by suitable measures

in consultation with Schaeffler if the system shows a reduction in it. According to the overall score, which is calculated during the evaluation period, the suppliers are classified into an ABC classification, as shown in Table 3.

Table 3. Supplier's ABC classification (Source: [37])

Points/ Classification	
$100 \geq A \geq 90$	The requirements are fully met
$90 \geq AB \geq 80$	The requirements are largely met There's potential for improvement from the supplier
$80 \geq B \geq 60$	The requirements are not sufficiently met The supplier must introduce suitable measures for improvement and report on the progress of the implementation if required
$60 \geq C \geq 0$	The requirements are not met The supplier must introduce suitable measures for improvement and report on the progress of the implementation if required, depends on the circumstances Schaeffler have the right to check the implementation on site

The overall quality (GKZ Q) comprises four criteria:

- Quality performance (QKZ)
- QM certificates (ZKZ)
- Sample performance (MKZ)
- Sustainability and corporate responsibility (CKZ)

The evaluation calculations for each criterion are described below:

Quality performance (QKZ):

It's calculated based on two individual criteria QKZ1 and QKZ2 which are determined according to the quality defect notifications within a certain assessment period.

The quality performance QKZ is calculated using the following formula:

$$QKZ = 0.75 \times QKZ1 + 0.25 \times QKZ2 \quad (1)$$

Where mass production quality QKZ1 is the ratio between the number of quality defect notifications and the number of goods inwards items.

$$QKZ1 = 100 - 1000 \times \frac{\text{Number of quality defect notifications (cases) in mass production (factor 2 with detection location K0 and KF)}}{\text{Number of goods inwards items in total (Max 500)}} \quad (2)$$

- If QKZ1 is less than 1 a value of one is always assigned to QKZ1.
- 10% of deliveries are the subject of concerns, then QKZ1 is 1 instead of 0.
- quality defect notifications with detection location K0 = Yard hold or zero kilometers or KF = delivery stop or field failure.
- Customer complaints caused by the supplier (K0, KF) are counted with a factor of 2.
- The number of goods is a maximum of 500 in a period of 6 months.
- The KPI cannot be a value less than 1.

QKZ2 is calculated as follows:

$$QKZ2 = 100 - B \times (\text{ppm value}) / 100 \quad (3)$$

$$\text{ppm} = (\text{delivery quantity rejected}) / (\text{delivery quantity in total}) \times 1000000 \quad (4)$$

- ppm: parts per million
- factor B in equation (3) is the commodity factor which is a specific compensation factor for handling different requirements.
- If the calculated value is less than 1 a value of 1 is assigned for QKZ2, except for oil and greases QKZ2 is not considered so it's 0.

QM certification (ZKZ):

Schaeffler requests evidence of the QM system from the suppliers based on the IATF 16949. Furthermore, expired certifications and special status notifications with the escalation status "NBH" have an influence on the evaluation. The KPI certification ZKZ receives points according to the certificates according to Table 4.

Table 4. Points received for ZKZ (Source: [36])

Certification	A	B	C	D
IATF 16949, VDA 6.1, AS 9100 or ISO/TS 22163	100	100	0	
ISO 9001	90	100	0	
Escalation status New Business Hold qualitative (NBH) or quality certificate expired	59	59	0	59
No QM-system	1	1		1
ISO IEC 17025				100
Self-declaration ISO IEC 17025				90

Note: A) Production material suppliers; B) Suppliers for profiles, raw materials for friction, and plain linings; C) Not relevant to evaluation for part-specific tooling, plastic injection molding tooling, and packing materials; D) calibrating service provider.

- If Schaeffler imposes the status "new business hold" for qualitative reasons or the quality certificate of the supplier is expired, GKZ and ZKZ are reduced to 59 points class C which means that the supplier is not quality capable and should not send enquires to the new project.
- If the status NBH is rescinded the original number of points awarded will be given again to the supplier.

Corporate responsibility (CKZ):

Based on the individual criteria weighting for CKZ, a devaluation of GKZ occurs if the suppliers did not fulfill any of the 3 criteria

shown in equation 5. If the supplier was not able to provide any certificate, he must be confirmed by the recognition of Schaeffler code of conduct that he is acting responsibly in sustainability aspects.

The corporate responsibility CKZ is calculated as follows:

$$CKZ = 0.4 \times CKZ1 + 0.3 \times CKZ2 + 0.3 \times CKZ3 \quad (5)$$

If CKZ = 1, GKZ is downgraded by 1 class.

Based on the environmental management system introduced by Schaeffler which requires appropriate certificates from the suppliers, CKZ 1 is receive point based as the following:

- EMAS: 100 points
- ISO 14001: 90 points
- No environmental certificate or expired certificate: 1 point

An occupational health and safety system has been introduced by Schaeffler as well which requires appropriate systems from the suppliers, the criterion CKZ 2 receives points based on that as the followings:

- OHSAS 18001 or ISO 45001: 100 points
- No occupational health and safety system present or certificate expired: 1 point

For criterion CKZ 3, Schaeffler expects recognition of supplier code of conduct (SCoC) or Schaeffler code of conduct (CoC) from the

suppliers. The supplier can also confirm its own code of conduct for Schaeffler. The points are given for CKZ 3 as the following:

- Schaeffler SCoC or CoC: 100 points
- Alternative CoC: 90 points
- No SCoC or CoC presented: 1 point

Sample quality (MKZ):

The sample quality performance is calculated as QKZ 1 but it's referred to as volume production quality. If the calculated value is less than 1, a value one is assigned for MKZ. If 20 % of sample deliveries are the subject of complaints, the MKZ value is therefore 1 instead of 0.

$$MKZ = 100 - 500 \times \frac{\text{Number of quality defect notifications (number of cases) on samples}}{\text{Number of goods inwards items in total (max. 500)}} \quad (6)$$

Overall Delivery performance (LKZ):

The delivery performance is calculated based on three individual criteria with different weightings:

- Date reliability LKZ1: 40%

- Quantity reliability LKZ2: 40%
- Logistics quality LKZ3: 20%

The delivery performance is calculated as follows:

$$LKZ = (0.4 \times LKZ1 + 0.4 \times LKZ2 + 0.2 \times LKZ3) / (0.4 + 0.4 + 0.2) \quad (7)$$

If the suppliers are involved in subcontract work, coating, and heat treatment, the delivery performance is calculated in accordance with logistics quality only (LKZ3) with 100% weighting. The logistics quality LKZ3 is calculated on the same basis as QKZ1 using logistics quality defect notifications occurring within the evaluation period in relation to volume

products. Quality defect notifications relating to logistics include missing documentation, packaging errors, damage to the packaging, and delays in delivery which are associated with the additional outlay for Schaeffler and production line stoppages at Schaeffler or at its customers' premises.

$$LKZ\ 3 = 100 - 1000 \times \frac{\text{Number of quality defect notifications (number of cases) relating to logistics}}{\text{Number of goods inwards items logistics (max. 500)}} \quad (8)$$

If the calculated value is less than 1, a value of 1 is assigned for LKZ 3. If 10% of deliveries are the subject of complaints, LKZ 3 is therefore 1 instead of 0.

$$VKZ = (0.8 \times VKZ1 + 0.2 \times VKZ2) / (0.8 + 0.2) \quad (9)$$

Overall VMI (Vendor Managed Inventory):

The KPI for supplier evaluation VKZ VMI comprises 3 individual criteria with different weightings:

- Quantity Reliability (VKZ 1): 80%
- VMI Logistics Quality (VKZ 2): 20%

The delivery performance VKZ is calculated using the following formula:

VKZ 1 is determined based on the daily inventory measurements in comparison with the minimum and maximum limits agreed with the suppliers. Points are deducted if the actual values are above or below the limits. The logistics quality VKZ 2 is determined on the same basis as QKZ 1 using logistics quality defect notifications occurring within the evaluation period in relation to volume products that are identified as VMI materials.

$$VKZ\ 2 = 100 - 1000 \times \frac{\text{Number of quality defect notifications (number of cases) for VMI material}}{\text{Number of goods inward items for VMI material (max.500)}} \quad (10)$$

If the calculated value is less than 1, a value of 1 is assigned for VKZ 2. If 10% of deliveries are the subject of concerns, the VKZ 2 value is therefore 1 instead of 0.

5. Results and Discussion

A detailed explanation has been made about the different approaches Schaeffler have used to understand the enrollment of the suppliers in sustainable development for economic success while at the same time assuming responsibility for the environment and society. Three themes were determined, and the literature was reviewed to understand the relationship between themes and terms. The supplier evaluation systems addressed economic, environmental, and social criteria for Schaeffler to attain the most sustainable outcome possible.

In terms of social, transparency, respect, and dignity, refrain from unlawful harassment, Fair working conditions, fair competition, respect of human rights, Rejection of forced and child labour, avoidance of conflict interests and integrity etc. Social criteria appear very important, and relatively large numbers are applied and mentioned in Schaeffler's policy. Schaeffler's supplier code of conduct contains the social regulations which each supplier must approve and apply and as a part of the company's social responsibility, the conflict minerals policy comes to address the human rights within the supply chain and to show that the company products are conflict-free. In the supplier evaluation system, the social criterion is taken under the term "corporate responsibility (CKZ)", which is counted as a devaluation factor for the suppliers with 60% overall weighting of the overall factor divided by 30% for the Code of Conduct and 30% for safety and health protection with 100 points given if the supplier is certified in OHSAS 18001 or ISO 45001.

As corporate responsibility has a direct influence on the overall supplier evaluation (GKZ) the overall rating is downgraded by 1 class if the supplier doesn't fulfill any of the three individual criteria of (CKZ). In general, social criteria in Schaefflers' case are not applied in a manner and to the extent which makes it really influences the overall score for the suppliers because they are more likely sub-categories for a devaluation factor that contains three different categories and won't affect the overall score of the suppliers if only one of the categories is not met. If the supplier doesn't provide any social

related certificates the SCoC is counted to be enough since it gives an insight into how responsible the suppliers act in their framework in the spirit of sustainability aspects.

The environmental criteria in the supplier evaluation system are taken as a sub-category lays down under the term "Corporate responsibility (CKZ)" which was mentioned before as a devaluation criterion that downgrades the overall score of the supplier by one step if the supplier fulfilled none of the three sub-categories. The environmental certificates are given a weight of 40% out of the overall weighting with 30% to SCoC, which contains both social and environmental regulations. The supplier is asked to provide one of the environmental certificates EMAS or ISO 14001 with 100 and 90 points for each and if the supplier didn't provide any certificate then the term CKZ 1 is given 1 point in the evaluation criteria. As the social criteria, the environmental criteria are not applied in a manner that gives it high importance and effectivity in the supplier evaluation system to improve and impair the sustainability performance of the organization.

Sustainability strategies should take into consideration the uncertainty of the future and unpredictable actions which may increase the level of logistics complaints due to unexpected phenomena. Therefore, the whole supplier evaluation system will be modified in order to meet up with the existing situation. From here it's important to pre-empt the events with an emergency plan included in the supplier evaluation system and accepted by the suppliers about how the work must be done in case of emergencies that have a direct effect on the flow of the materials and products to avoid economic, social, and environmental consequences on the organization itself and on the whole world in certain cases.

In emergencies that require shutting borders or locking down cities, the supplier won't be able anymore to deliver at the exact time and with the required quantity, and in some cases, that might put human beings' life in danger, especially for those who are working in transportation in another hand that might affect the environment in a general form. All of these will affect the profit of the organization in return and hit the overall goal of sustainability with a direct effect on the three-bottom line of sustainability (planet, people, profit). High logistics complaints may occur in these cases, leading to the unfair exclusion of the supplier due to natural reasons.

Conclusion

An analysis of the supplier evaluation system was done for Schaeffler to figure out how did they implement sustainability in their supplier evaluation system which agrees with what been mentioned in the literature about the importance of the supplier evaluation as one of the most effective and critical approaches that must be involved in the development process of the organization.

A combination of using the social and environmental criteria as key performance indicators for the suppliers as the model of Schaeffler in an effective way by considering them as knock-out factors rather than only devaluation factors with applying some monitoring systems might build up a more effective evaluation system with continuous testing, social media monitoring and the usage of the trust line for detected misconducting suspicions.

The importance of participating of the suppliers in the improvement towards sustainability is widely agreed upon in the literature since the suppliers have a direct effect on the final product and their activities are directly influencing the purchasing company in different aspects. The evaluation systems for the suppliers differ from one field to another and it might have some differences between companies in the same field as well.

References

- Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics*, 143, 37–46.
- Europe INNOVA (2012), Guide to resource efficiency in manufacturing: Experiences from improving resource efficiency in manufacturing companies, available at [https://www.greenovate-europe.eu/sites/default/files/publications/RE_Make_Greenovate!Europe%20%20Guide%20to%20resource%20efficient%20manufacturing%20\(2012\).pdf](https://www.greenovate-europe.eu/sites/default/files/publications/RE_Make_Greenovate!Europe%20%20Guide%20to%20resource%20efficient%20manufacturing%20(2012).pdf)
- Verghese, K., & Lewis, H. (2007). Environmental innovation in industrial packaging: a supply chain approach. *International Journal of Production Research*, 45(18-19), 4381–4401.
- Preston, F. (2012). A global redesign? Shaping the circular economy. London: Chatham House.
- Dora, M., Bhatia, M. S., & Gallear, D. (2016). Supply chain in a circular economy: a multidimensional research agenda. 3rd International Conference on Green Supply Chain, (2016).
- González, M. E., Quesada, G., & Mora Monge, C. A. (2004). Determining the importance of the supplier selection process in manufacturing: a case study. *International Journal of Physical Distribution & Logistics Management*, 34(6), 492–504.
- Hashemi, S. H., Karimi, A., & Tavana, M. (2015). An integrated green supplier selection approach with analytic network process and improved Grey relational analysis. *International Journal of Production Economics*, 159, 178–191.
- Andersen, M. S. (2006). An introductory note on the environmental economics of the circular economy. *Sustainability Science*, 2(1), 133–140.
- Murray, A., Skene, K., & Haynes, K. (2015). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*, 140(3), 369–380.
- Clark, J. H., & Macquarrie, D. J. (Eds.). (2008). *Handbook of green chemistry and technology*. John Wiley & Sons.
- Greyson, J. (2007). An economic instrument for zero waste, economic growth and sustainability. *Journal of Cleaner Production*, 15(13-14), 1382–1390.
- Liu, Q., Li, H., Zuo, X., Zhang, F., & Wang, L. (2009). A survey and analysis on public awareness and performance for promoting circular economy in China: A case study from Tianjin. *Journal of Cleaner Production*, 17(2), 265–270.
- Yuan, Z., Bi, J., & Moriguchi, Y. (2008). The Circular Economy: A New Development Strategy in China. *Journal of Industrial Ecology*, 10(1-2), 4–8.
- Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018). Circular economy – From review of theories and practices to development of implementation tools. *Resources, Conservation and Recycling*, 135, 190–201.
- Pitchipoo, P., Venkumar, P., & Rajakarunakaran, S. (2014). Grey decision model for supplier evaluation and selection in process industry: a comparative perspective. *The International Journal of Advanced Manufacturing Technology*, 76(912), 2059–2069.
- Dickson, G. W. (1966). An Analysis of Vendor Selection Systems And Decisions. *Journal of Purchasing*, 2(1), 5–17.
- Lasch, R., Janker, C.G., 2005. Supplier selection and controlling using multivariate analysis. *Int. J. of Phys. Distrib. & Logist. Manag.* 35 (6), 409–425.
- Banker, R. (1995). Economics of operations management: A research perspective. *Journal of Operations Management*, 12(3-4), 423–435.

19. Koplin, J., Seuring, S., & Mesterharm, M. (2007). Incorporating sustainability into supply management in the automotive industry – the case of the Volkswagen AG. *Journal of Cleaner Production*, 15(11-12), 1053–1062.
20. Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699–1710.
21. Keskin, G. A. (2014). Using integrated fuzzy DEMATEL and fuzzy C: means algorithm for supplier evaluation and selection. *International Journal of Production Research*, 53(12), 3586–3602.
22. Monczka, R.M., Trent, R.J., Handfield, R.B., 2005. *Purchasing and Supply Chain Management*, 3rd Edition, South-Western, Mason.
23. Zhang, X., Lee, C. K. M., & Chen, S. (2012). Supplier evaluation and selection: a hybrid model based on DEAHP and ABC. *International Journal of Production Research*, 50(7), 1877–1889.
24. Ellram, L. M. (1990). The Supplier Selection Decision in Strategic Partnerships. *Journal of Purchasing and Materials Management*, 26(4), 8–14. [24] Noci, G. (1997). Designing “green” vendor rating systems for the assessment of a supplier’s environmental performance. *European Journal of Purchasing & Supply Management*, 3(2), 103–114.
25. Klassen, R. D., & Vachon, S. (2003). Collaboration and evaluation in the supply chain: The impact on plant-level environmental investment. *Production and Operations Management*, 12(3), 336–352.
26. Awasthi, A., Chauhan, S. S., & Goyal, S. K. (2010). A fuzzy multicriteria approach for evaluating environmental performance of suppliers. *International Journal of Production Economics*, 126(2), 370–378.
27. Hu, Z., Rao, C., Zheng, Y., & Huang, D. (2015). Optimization Decision of Supplier Selection in Green Procurement under the Mode of Low Carbon Economy. *International Journal of Computational Intelligence Systems*, 8(3), 407–421.
28. Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review*, 14(4), 532–550.
29. Simons, H. (2009). Evolution and concept of case study research. In Simons, H. *Case study research in practice* (pp. 12–27) page 21.
30. Thomas, G. (2011). A Typology for the Case Study in Social Science Following a Review of Definition, Discourse, and Structure. *Qualitative Inquiry*, 17(6), 511–521.
31. Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The Case Research Strategy in Studies of Information Systems. *MIS Quarterly*, 11(3), 369–386.
32. Schaeffler: Schaeffler Group Corporate Supplier Code of Conduct, online: https://www.schaeffler.de/remotemedien/media/_shared_media/08_media_library/01_publications/schaeffler_2/brochure/downloads_1/schaeffler_supplier_code_of_conduct_en.pdf , Downloaded: 2020.2.15. 4:29:17 PM.
33. efficient cooperations between customer and supplier, online: https://cms.application.prd.supplyon.com/sites/default/files/supplier_info_portal/Schaeffler/supplier_brochure_schaeffler_supplyon.pdf , Downloaded: 2020.2.26. 12:30 PM.
34. SupplyOn: Supplier Portal of Schaeffle, Supplier brochure, online: https://cms.application.prd.supplyon.com/sites/default/files/supplier_info_portal/Schaeffler/supplier_brochure_schaeffler_supplyon.pdf , Downloaded: 2020.2.21. 9:27:29 AM.
35. Schaeffler: Supplier Evaluation on Finished Goods-Relevant Products, Processes and Services, Calculation Principles and Rules, online: https://www.schaeffler.hu/remotemedien/media/_shared_media_rwd/01_company_1/suppliers_4/supplier_evaluation_calculation_en.pdf , Downloaded: 2020.2.11. 7:56:42 PM.
36. Schaeffler: Supplier Evaluation on Finished Goods-Relevant Products, Introduction, online: https://www.schaeffler.hu/remotemedien/media/_shared_media_rwd/01_company_1/suppliers_4/supplier_evaluation_introduction_en.pdf , Downloaded 2020.2.11. 7:34:59 PM.

BIOECONOMIC PRINCIPLES FOR ENHANCING AGROECOSYSTEMS AS "PROTEIN FACTORIES" IN AN INCREASINGLY HUNGRY PLANET

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Abstract: The paper outlines a nuance of scientific knowledge that mediates the reflection of the specific reality of the contemporary world and outlines a well-founded interpretation of the evidence related to the typology of the "Living Planet", regarding the structure and functionality of its agro-ecosystems in relation to society and to the concern for food security. The paper brings together multiple concepts and methodological approaches, describing areas of inflection with potential for bio-economic harmonisation of human nutrition. The idea of "One Health" is analysed from the perspective of food ecosanogenesis in the direction of biodiversity and on the basis of specific principles and processes of energy bioconversion and metabolic biotransformation. In a synthetic diagnosis, which supports the bioeconomic remodelling of food production, biotechnological applications of agro-food biodiversity are analysed, detailing structural and functional aspects of agro-zoo-food modules, characterised by bio-harmonisation of economic efficiency with ecosystem effectiveness, based on specific indicators

Keywords: Bioconversion, Bioeconomy, Biotransformation, Ecosanogenesis, One Health.

1. Introduction

There is an urgent need for a science-based response and coherent policy directions to the cumulative crises (climate, pandemic, economic, conflict, etc.) converging with the accelerated need for adaptation and food system reform before an irreversible situation is reached [5,6,7,12,29,31,45].

The essential solution is linked to the performance of agro-ecosystems so that the production of plant and animal resources, especially with protein components that are valuable in terms of both quality and quantity, is considerably enhanced. For these objective

reasons, agro-ecosystems are regarded as veritable 'protein factories'.

In other words, they are the basic element in solving the scientifically proven problem of hunger through the widespread production and use of foodstuffs with a high protein content, both of animal origin (meat, eggs, cheese, fish, etc.) and of plant origin (nuts, beans, whole grains, etc.), as they are of major importance for the metabolic balance and health of the population [3,24,38,40].

Protein flow is the basis in the ecosystem food chain, which is reflected in the generalized idea of the systemic concept of ECOSANOGENESIS [21], described in the box in Fig. 1.

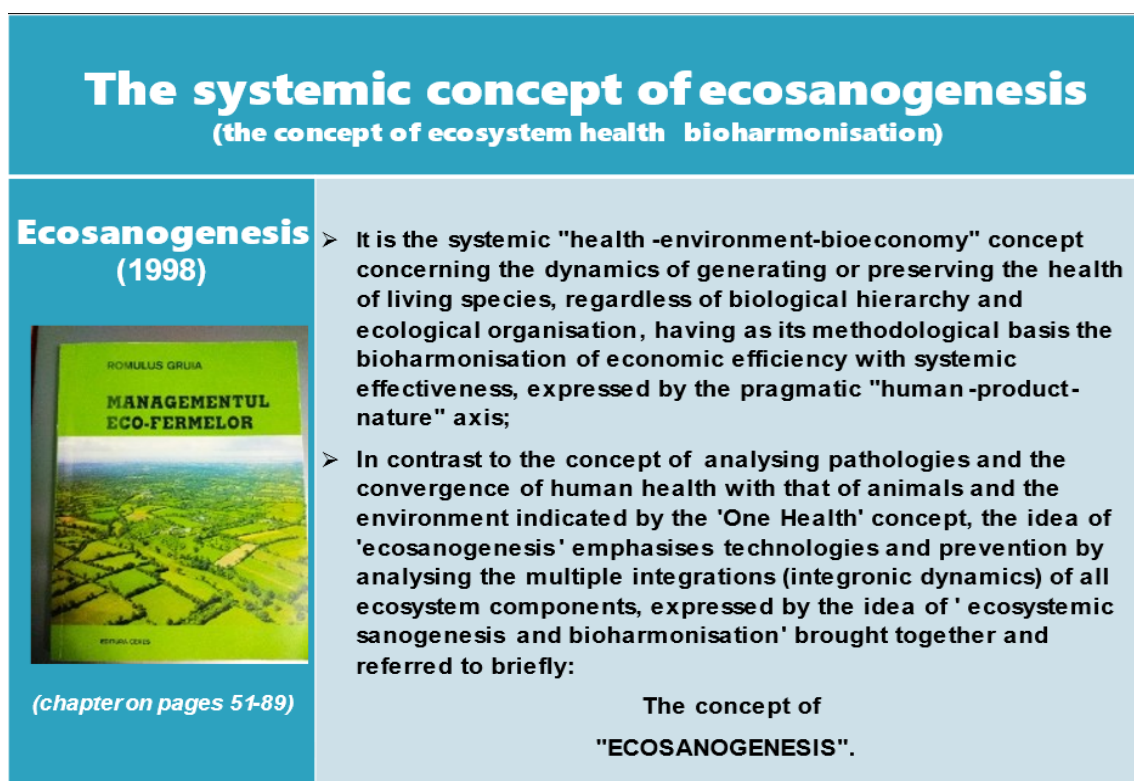


Fig.1. Principles and defining elements of the concept of holistic ecosystem health

The problem that may become more acute in the near future is the local food crisis in many parts of the world, but also globally, with unpredictable geopolitical consequences. It is therefore more than appropriate to take a systemic approach to the convergent relationship between animal species and humans, both in

terms of agro-zootechnology and environmental and health aspects. The steps taken in this direction have led in recent years to the phrase 'One Health' becoming internationally established for all animal components, including of course the human species (Figure 2).

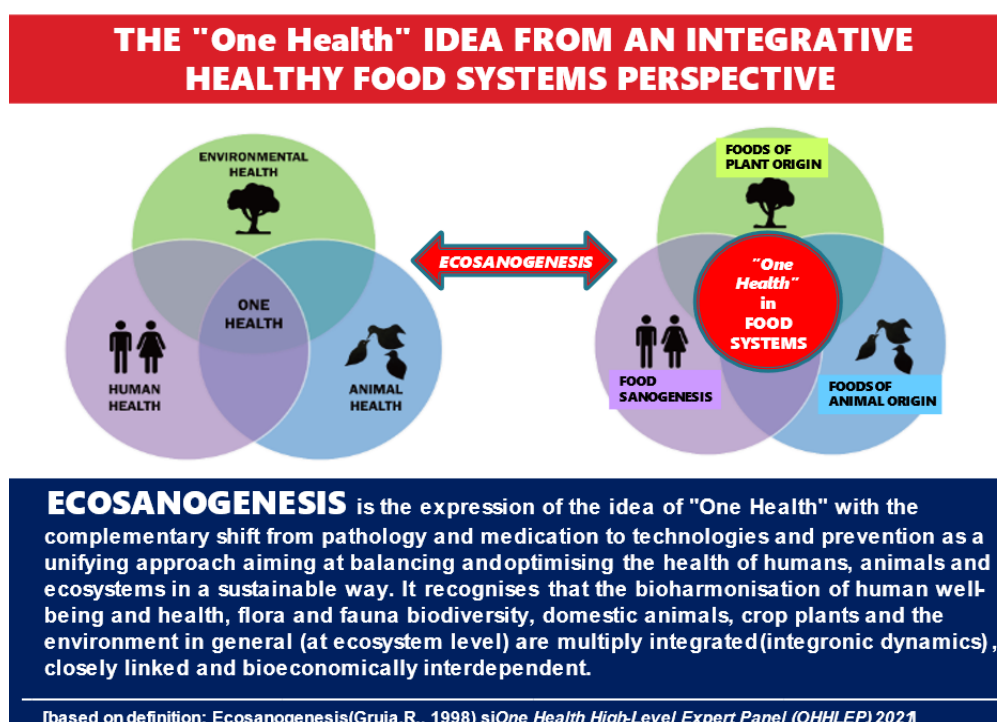


Fig. 2. Bioeconomic integration structures in agroecosystem functioning

Lately, a new spirit in food production is being imposed, i.e., beyond the aspects of standard economics, the issue of protecting and conserving the ENVIRONMENT and its resources is being raised, i.e., the BIOECONOMICS model is being developed [18,19,22,26].

Of course, many aspects are known being in different research phases, but the problem is far from being solved. Therefore, in an increasingly

hungry planet (especially in a simplified but essentially "protein starved" form) AGRO-ZOO-FOOD ECOSYSTEMS can make a saving contribution to feeding the world by maximizing bioeconomic returns at local, regional, including planetary balance, based on a series of convergent concepts and innovative technologies, expressed in syntheses in the box below [4,15,16,30,35,36,43,44].



International concerns are on multiple levels to find solutions for food security, such as applying Emergence Theory, General Theory of Integration, Concept of Ecological Modernization, etc. [22,41,42]. We can also mention some contributions on this topic through their own concepts and hypotheses, useful as a basis for discussion: the Theory of Ecoemergent Integrity [25] and the Theory of Modulation of Complex Agroecosystems [24].

All of them aim at: resizing the production system through modular integronic restructuring (both at ecosystem level and in controlled environment and space), aiming at the highest possible yield and emergent outcome as systemic evolution.

These are all innovative elements for global food security, but are directly linked to the social and political developments of the present and especially the coming decades. Therefore, it becomes mandatory to take into account the specific directions of action of the biological-informational society, the perceptions of Complexity sciences and their implementation in the specific ideas of the Knowledge Society and, why not, the Consciousness Society [1,2,8,10,11,13,14,32,33,37,39].

What is new about "bio-economic agro-zootechnics" is the conceptual interpretation, of course, but also the application of bio-economic and eco-development theories in relation to the field of food production. Bio-economically

oriented AGRICULTURE uses plant and animal resources through bioprocessing (i.e., increased nutrient, energy and metabolic biotransformation yields through agri-food biotechnologies), with the effect of increasing food quality, effectively becoming basic raw materials for industrial food products (composite foods) and gastronomic preparations (complex foods) [23,27,28].

The objective of this work is to highlight the eco-bioavailability and bio-transformations of agroecosystem components through bioeconomic modelling, i.e. to consider and quantify the environment in the economic equation. The focus of this approach is on the energy-nutrient aspects with the ultimate effect of ensuring food chain balances and bio-harmonisation at ecosystem level.

2. Working methodology

The work is based on the principles of eco-energy analysis and the use of agro-ecosystem dynamics concepts (integronics, bioconversion, biotransformation, emergence), eco-bio-geo information, statistical and eMergetic indicators.

3. Results and discussions

The planet is fluctuating annually, but with a tendency to enter a crisis in terms of global food security. It looks more and more like a 'starving planet'. It's hard to believe, but these days there are still densely populated areas of the globe where millions of people are starving (!). A managerial rethink and a technological reorientation in a green and informational direction are becoming mandatory [9,17,20,34].

A detailed analysis of the above-mentioned approach, which is the subject of research at agro-ecosystem level, highlights the importance of sanogenic feeding. In this context it is known that PROTEINS are those that can satisfy the

sensation of hunger better than fats and carbohydrates. They are essential nutrients for health, as proteins are responsible for a number of important functions in the body, including hormonal, enzymatic, cell repair and maintenance, muscle movement, etc.

Furthermore, there is concern that protein levels beneficially influence the risk of many diseases, including cardiovascular disease, Alzheimer's disease, diabetes, osteoporosis, eye diseases, etc.

An integrated analysis of the issue shows that the BIOECONOMICS approach supports the idea that: agro-zoo-food ecosystems are production modules, like real "protein factories". In order to highlight the above, research is needed on: the genesis, bioeconomic development and dynamics of bio-transformations specific to the agro-zoo-food industry of all types, taking into account the modules and flows of the food chain.

One direction of analysis is the approach to specific features of the dynamics of systemic bio-transformations.

In summary, we start from the idea that the bioeconomy concerns the economic development of the human species, associated with the laws of nature and, in particular, the Law of Entropy (linked to the second principle of thermodynamics). Why? Because entropy is the measure that indicates the degree of organization of a system, by transforming order into disorder, based on the analysis of entropic transformations of matter and energy, which is in fact the fourth law of thermodynamics (it belongs entirely to N. Georgescu-Roegen).

It shows, starting from the general to the particular, that by increasing entropy energy dissipates, becomes disorganized and difficult to access or unusable and even unavailable (fig.3).

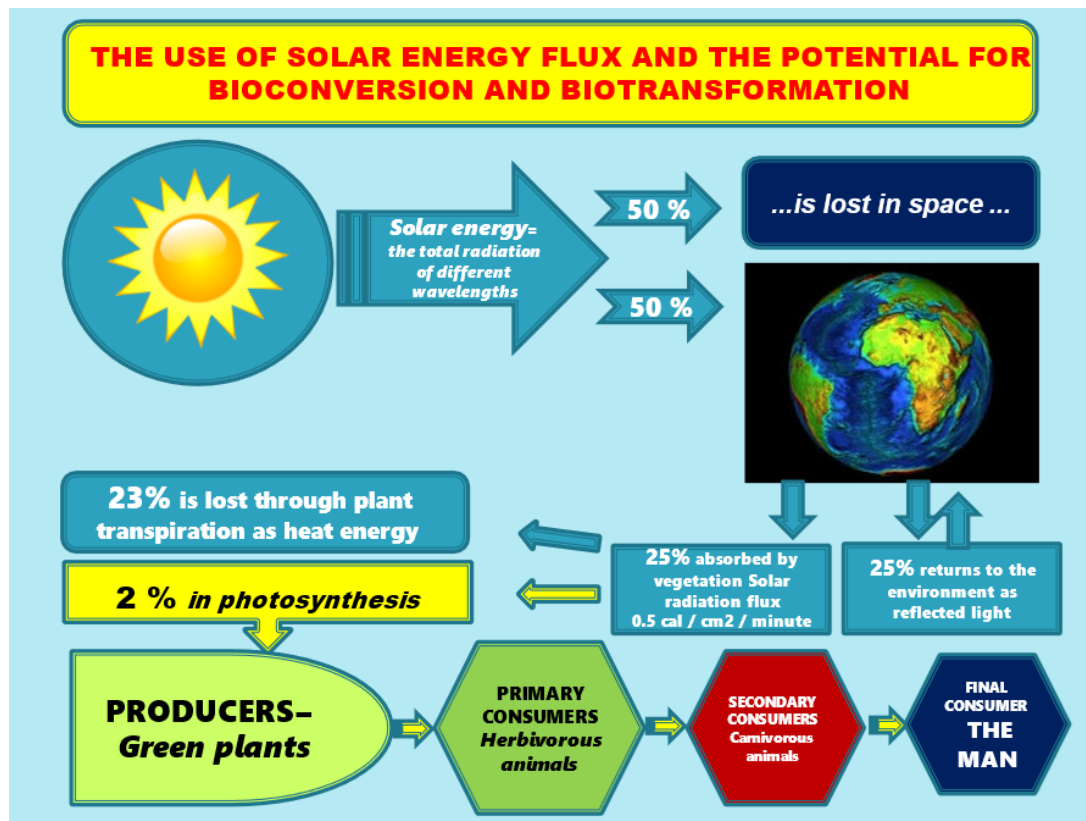


Fig. 3. Bioconversion at ecosphere level

What is of interest in the issues addressed in this paper is the main model of energy bioconversion

and related energy-protein biotransformations in human nutrition metabolism (Fig. 4).

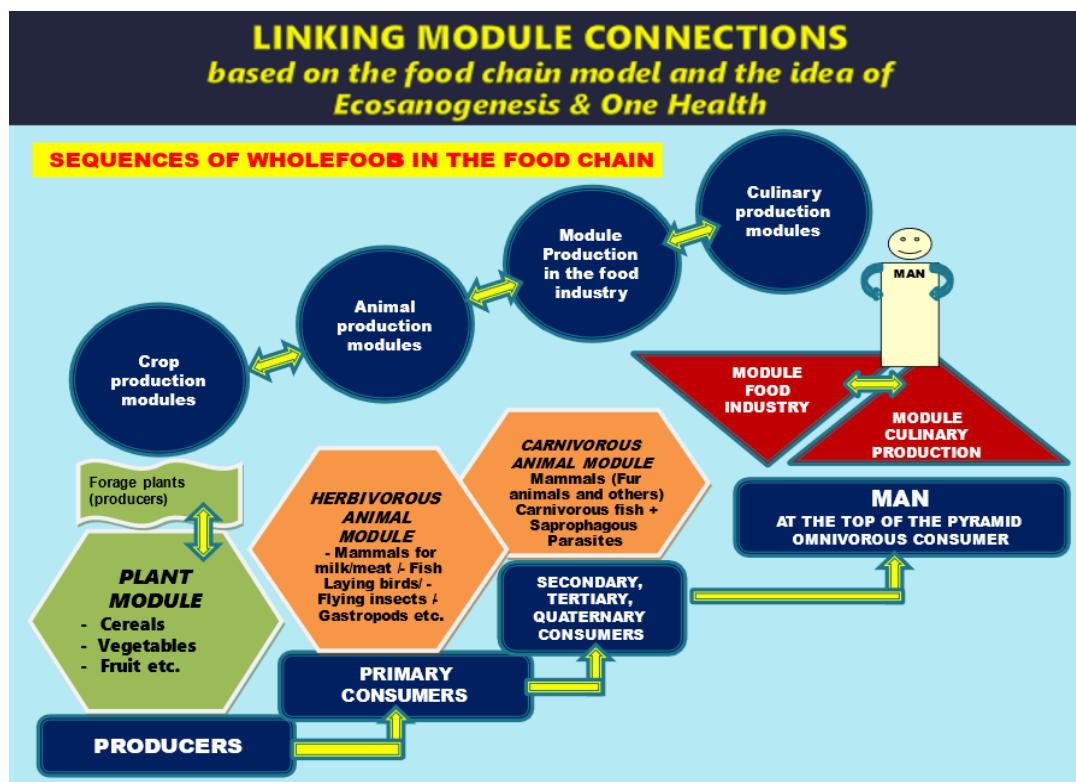


Fig. 4. Biotransformation chain in specific agroecosystem modules, starting with the plant module and continuing with related modules

In summary, the following aspects of BIOTRANSFORMS AND HRANA IN ECOSYSTEMS can be noted, namely, observing the context of agro-zoo-food production with its specificity: Quantity vs. Quality / Low Entropy vs. High Entropy / Yields vs. Waste and residues based on circular economy principles, etc. This is why the BIOECONOMIC approach becomes appropriate, but also with long-term solutions. In this sense "growth" is associated with QUANTITY and "development" with QUALITY, elements with applications in the bioeconomic model of food production.

Pragmatically, the problems of feeding a growing world population are precisely confined between quantity and quality, between extensive, intensive and industrial production systems, between open,

semi-closed or closed organizational systems, all as typologies of agro-ecosystems.

In short, the typology of ecosystem biotransformations in a food chain in the bioeconomic model of food production systems shows that for the food required by individuals in a biocenosis, including humans, we also need to know the degree of metabolic assimilation, i.e., the percentage in which they are used by the body. Knowledge of food composition and the correct combination leads to better digestion, absorption, bioavailability and, finally, to the analysis of the biotransformation process at the organismic level and, in systemic reality, of the successive ECO-BIODISPONSIBILITY process at the ecosystemic level (Table 1).

Table 1. SPECIFIC DYNAMIC PROCESSES AT AGRO-ECOSYSTEM LEVEL

SPECIFY	DESCRIPTION
ECO-BIOAVAILABILITY	– Energy bioconversion expressed implicitly also by the fraction of the total amount of food and energy-nutrient components of food that reach the metabolic circuit of an organism integrated in the food chain of a given ecosystem.
ORGANISMIC BIOTRANSFORMATION	– Metabolic biotransformation expresses the totality of physico-chemical and sensory transformations that a food undergoes in processing cycles, changes in ecological, biological, physical and chemical properties that influence its yield and efficacy at each trophic level or level of food processing.

At the ecosystem level, the analysis of eco-bioavailability characteristic of agro-ecosystem types in relation to the food groups specific to the

main agro-food activities is therefore eloquent (Figure 5).

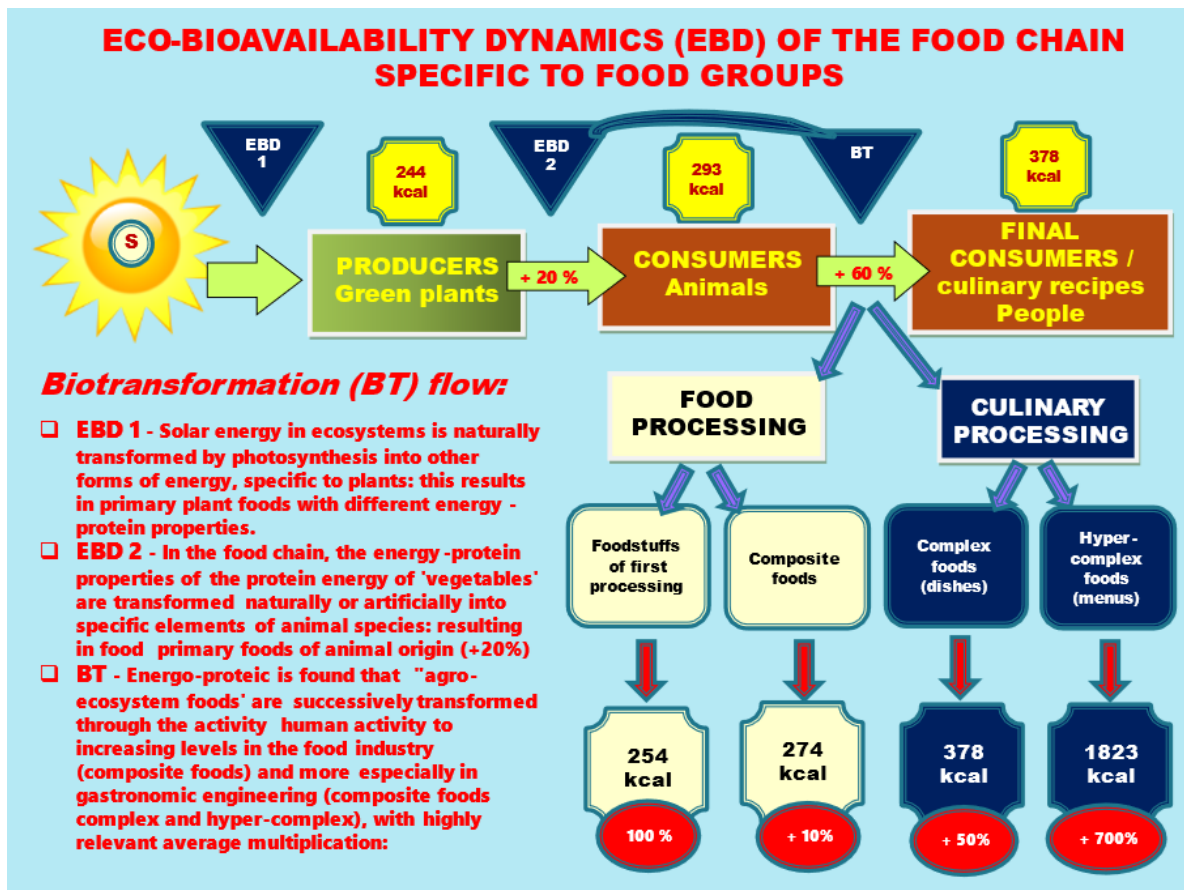


Fig. 5. Successive average biotransformations at agroecosystem level

It can be seen in principle that eco-bioavailability is directly linked to the processing of agri-food

products and hence the added value from an energy and hence financial perspective (fig.6).

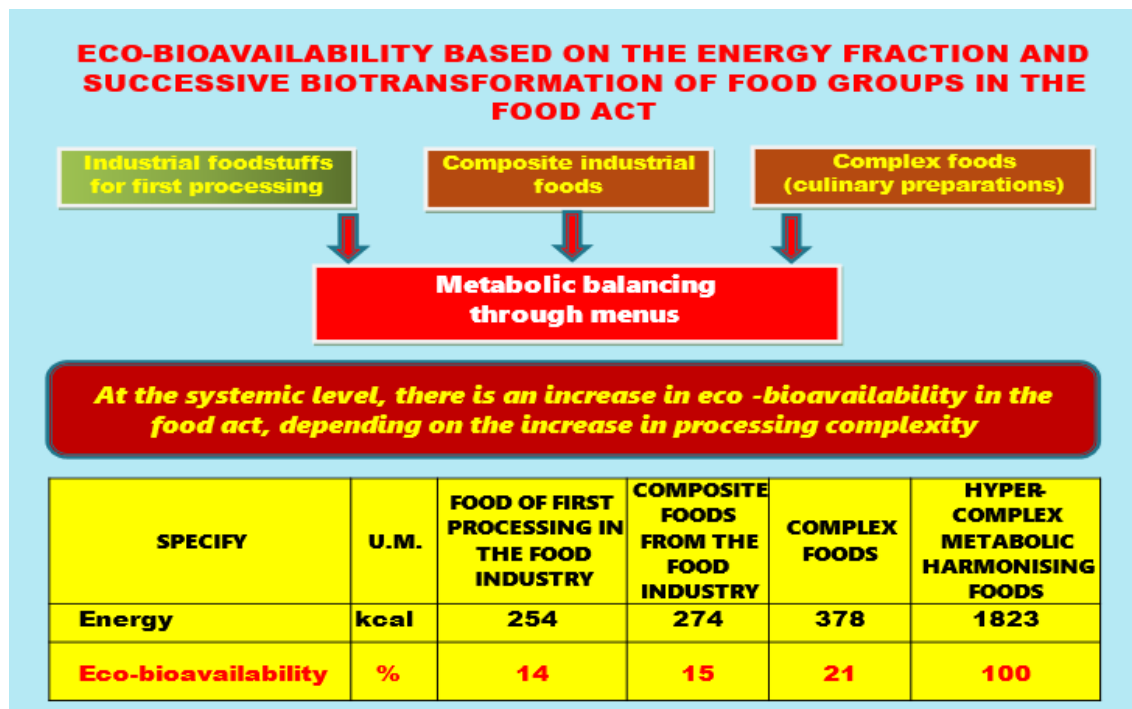


Fig. 6. Scale of increasing eco-bioavailability in the food processing chain

In view of the above, we highlight the bioeconomic perspective, which refers to the holistic approach of organization, control and evaluation based on the principles, rules and working methods of integrated management [25]. In practice, agroecosystems can be managed by highlighting the energy-protein linkage in the food chains specific to the given system and hence the direct relationship with prices.

The framework provided by integrative management refers to the scientific approach that studies integrated systems and integration processes, taking into account global elements and facts as a whole, considering the MANAGEMENT of complex, synchronous and

syncretic systems, based on emergent integration and synergy.

Without going into details we specify that applicable is the very objective proposed by this type of integrative management, i.e. to give solutions to the complexity of problems by applying eco-energetic (eMergetic) analysis in the case of agro-ecosystems [21] and in general of hypercomplex systems (of the Environment-Economy type), which can factually achieve BIOECONOMIC

AGRO-ZOO-FOOD MODULES, characterized by bioharmonization of economic efficiency with ecosystem effectiveness, expressed by specific indicators listed in Table 2.

Table 2. INDICATORS USED IN THE INTEGRATED MANAGEMENT OF AGROECOSYSTEMS

No.	INDICATOR	Observations
1	The flow of energy externalities (I)	Systemic indicators based on analysis eMergetics a AGROECOSYSTEMS which highlights the process of ECOSANOGENESIS & "One Health" necessary to enhance food production
2	High quality input stream (F)	
3	High quality output stream (Y)	
4	Net eMergetic yield (%)	
5	Environmental work intensity (im)	
6	The eEnergy investment report	
7	Energy externality (xE)	
8	eMergetic externality rate (ξ)	
9	Monergy (mE)	
10	Exergy	
11	The macro prices of the environment	
12	Ecosystem Effectiveness(e)	
13	The real economic process (ρ)	
14	Environmental externality (I ⁺)	
15	Drainage index (emD)	
16	Sustainability coefficient (E ³)	

Note that the applications and case studies can be taken as a model for further analysis from this agro-ecosystems perspective.

It is in fact the level of analysis of these complex systems that makes the transition from standard economic efficiency to ecosystem efficiency specific to bioeconomic approaches, with applications to food systems, species, plant and/or animal products and food assortments.

Conclusions

1. In the economics and technology of food production we must turn our attention to the "unregulated" solar energy flow, which is decreasing in intensity over the very long term; as the Sun's entropic degradation decreases, so does the finite supply of natural resources of the various terrestrial areas.

2. The bioeconomic model for food production is based on solar energy and biotransformation dynamics. All food production is based on low

entropy, i.e. diverse agri-food production, which are ordered structures, so that in the bioeconomic model increasing food complexity means increasing structural organisation and decreasing entropy supported by the eco-biotransformation process (eloquently expressed eMergetic).

3. Eco-bioavailability and biotransformation lead to a decrease in entropy, so that plants provide on average 20% more energy bioconversion through biotransformation into animal products, and biotransformation through culinary products increases on average to 60% of the energy supply of plants and 40% of the energy supply of animal products.

4. The eco-bioavailability of food in the food chain is convergent with the successive biotransformations of food processing, with an increase in eco-bioavailability in the food chain at the agro-ecosystem level, depending on the increasing complexity of preprocessing. Thus, the fraction of total food that harmonises metabolism by covering energy-protein requirements is based on first-processed foods (covering 14% of the total), on composite industrial foods (just over 15%), with complex culinary foods having an average eco-bioavailability of 21%.

5. The trophic flow indicates an enhancement of food quality through the protein structure of the food achieved in protein manufacturing agro-ecosystems, an enhancement that is directly linked to the biotransformation of food processing, which indicates increased bioeconomic yield and supports multiple integrations that ensure the presence of ecosanogenesis of the whole flow, with complementary health effect supporting practically the idea of "One Health" at all systemic levels.

References

1. Afgan N.H., Carvalho, Maria G., 2010: The Knowledge Society: A Sustainability Paradigm, Cadmus, (www.cadmusjournal.org/), 2 Oct.2010, 17 pp.;
2. Albrecht, K., 2007: Inteligența socială. Noua știință a succesului, Ed. Curtea Veche, București;
3. Antonovics, J., 1978: The input of population genetics, "The new ecological genetics", Systematic Botany 1(3), 233-243;
4. Bache, M.C., 2000: Anima mundi - Ecological crisis and death of the ego of the species: speculation on the future, The Journal of Transpersonal Psychology, Vol.32, Nr.1, 25-32;
5. Ball, T., Dagger, R., 2000: Ideologii politice și idealul democratic, Ed. Polirom, 17-33;
6. Barry, R.J.J., 1995: Globalisation and Interdependence in the International Political Economy, Rethoric and reality, Pinter Publishers, London, 50-75;
7. Bell, D., 2001: The End of Ideology. On the Exhaustion of Political Ideas in the Fifties, Harvard University Press, Cambridge, Mass;
8. Brown, L., 2010: The Evolution of Public Sector Strategy, Public Administration Review, Vol.70, (<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1540-6210.2010.02275.x>);
9. Buican, D., 1993: Biognoseologie, evoluție și revoluție în cunoaștere, Ed. All București;
10. Dasen, Pierre, Christine Perregaux, Micheline Rey, 1999: Educația interculturală. Experiențe, politici, strategii, Iași, Editura Polirom, 1999;
11. Drăgănescu, M., 2007: Societatea conștiinței, Institutul de Cercetări pentru Inteligență Artificială al Academiei Române, ISBN 978-973-0-05307-4 în sursa: <https://www.scribd.com/>;
12. Drucker, P.F., 1999: Societatea post-capitalistă, Editura Image, București;
13. Esposito, R., 2008: Bios: Biopolitics and Philosophy. U of Minnesota Press. p. 16. ISBN 978-0-8166-4989-1;
14. Frey, B.S., 1999: Economics as a Science of Human Behaviour, Towards a New Social Science Paradigm, Kluwer Academic Publishers, Boston;
15. Fukuyama, F., 1992: The End of History and the Last Man, New York, The Free Press;
16. Fukuyama, F., 1999: The Great Disruption. Human Nature and the Reconstruction of Social Order, New York, The Free Press;
17. Gaceu L., Gruia R., 2006, Sisteme informatice în management, Ed. Infomarket Brașov, ISBN (10) 973-8204-86-0, ISBN (13) 978-973-8204-86-7, 208 p.;
18. Georgescu-Roegen, N., 1971: The entropy law and the economic process, Harvard Univ. Press, Cambridge, Mass.;
19. Georgescu-Roegen, N., 1979: Legea entropiei, Ed. Politică, București, 688 p.;
20. Ginman, M., 1988: Information culture and business performance. IATUL Quarterly, 2(2), 93-106;

21. Gruia, R., 1998: Managementul eco-fermelor, Ed. Ceres Bucuresti, 973-40-0425-5, Conceptul de ecosanogeneză, 68-73; Un concept integrator: bioasofia, 74-85;
22. Gruia, R., 2002: Ecoemergetic theory in sustainable development, Ed. Univ. Transilvania Braşov ISBN 973-635-022-3, 3-104;
23. Gruia, R., 2008: Gastronomic engineering, a distinct direction within food engineering, Journal of EcoAgriTourism, Publishing Transilvania University of Brasov, Romania, ISSN: 1844-8577, Vol.4 (2008), nr.1-2, p.10-16;
24. Gruia, R., 2010: Modular agriculture – paradigm of globalization dynamics within the context of climatic and scientific changes, Environmental Engineering and Management Journal, "Gheorghe Asachi" Technical University Iasi, ISSN 1582-9596, Vol.9, nr.12, 1601-1606;
25. Gruia, R., 2013: Bazele managementului si directiile viitoare de evolutie, Ed. Lux Libris ISBN: 978-973-131-230-9, Cap.15,16 Managementul integronic, 163-197;
26. Gruia, R., 2016: Zootehnia bioeconomică, Editura Lux Libris Braşov ISBN: 978-973-131-357-3, 5-364;
27. Gruia, R., 2017: Resurse genetice în fermele agroturistice, Editura Clarion Braşov, ISBN 978-606-94470 -0-0, Cap.11,12, Genetica biocenozelor, 147-188;
28. Gruia, R., 2019: Bioarmonismul, de la teorie la o nouă ideologie, Editura Clarion Braşov, ISBN 978-606-94470-6-2, 3-241, Cap.3 Legea infogronică 63-71;
29. Gruia, R., 2019: Ideologia bioarmonistă, Editura Clarion Braşov, ISBN 978-606-94470-7-9, 3-50;
30. Harari, Y.N. 2017: Sapiens - scurtă istorie a omenirii, Ed. Polirom Iaşi, 9-10, 296-315;
31. Hawking, St., 2014: Teoria universală, Editura Humanitas Bucureşti, 123-140;
32. Kuhn, Th., 2008: Structura revoluţiilor ştiinţifice, Ed. Humanitas, Bucureşti (trad. Bogdan Radu, (studiu introductiv, Mircea Flonta);
33. Lemke, T., 2011: Biopolitics: An Advanced Introduction. NYU Press. pp. 9–10, ISBN 978-0-8147-5241-8;
34. Mignerot, V., 2017: Transition 2017 - Réformer l'écologie pour nous adapter à la réalité, Association Adrastia / (<http://adrastia.org/transition-2017-1-realite/>);
35. Munteanu, Fl., 2015: Seminte pentru altă lume, Ed. Princeps Bucureşti, 137-192;
36. Munteanu, Fl., 2017: Studiu asupra abordării procesului de geostazie planetară, Lucrările celei de-a XI-a ediții a Conferinței anuale a ASTR, 200-205;
37. Peters, M.A., 2012: Bio-informational capitalism, <https://journals.sagepub.com/> (First Published June 26, 2012 Review Article);
38. Pillet, G., 1990: Economie de l'environnement et du patrimoine naturel. Revue economique, Vol. 41, Nr. 2, 321-333;
39. Smith, D.E., 1974: The Social Construction of Documentary Reality, Sociological Inquiry 44(4), 257-268;
40. Soran, V., Şerban, M.E., 1980: Bioeconomia – o nouă știință de graniță, Ed. Științifică și enciclopedică Bucureşti;
41. Stancovici, V., 1980: Filosofia integrării, Editura politică, Bucureşti.
42. Werner, W., 2006: Which Socio-economic Model for Europe? INTERECONOMICS January, Volume 41, Issue 1, p. 4–23;
43. Wilson, E.O., 2015: Cucerirea socială a Pământului, Humanitas, Bucureşti, 329 p.;
44. Zugrăvescu, D., Munteanu, Fl., 2011: Planeta Pământ - Planeta vie, Institutul de Geodinamică „Sabba G. Ștefănescu” al Academiei Române, Catedra UNESCO de Geodinamică - România, Eagle Publishing House, ISBN 978-606-8315-29-4, 45-47, 63-66, 90-94;
45. xxx - 2021: COP26 Climate Change Conference in Glasgow, 1-12, Nov.2021 (<https://web.cvent.com/event>).

RESEARCH ON THE ENERGY YIELD OF WOOD COMPOSITE MATERIALS

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Abstract: Biomass resources from which fuel is produced include wood and wood waste, agricultural grains and waste resulting from them production, aquatic biomass and algae. Biomass can be converted into solid, liquid and gaseous energetic fuel, which can generate both energy in the form of heat by burning it, and electricity through conversion processes. The use of renewable fuel materials such as forest residues for the production of biofuels increases the chances of biomass in terms of its availability the energy market. Renewable energies amount to 6.7% of the total primary energy consumption in the European Union. Renewable energy sources are the energy of the Sun, wind, water, biomass. The largest part of renewable energy production belongs to biomass, approximately 47% of the total energy produced by renewable energy sources, followed by hydro energy with 45%.

Keywords: energy yield, biomass, calorific value, composite materials

1. Introduction

Fuels are found in three forms, namely fossil, nuclear and renewable fuels. Fossil fuels according to research carried out by the European Union, seriously damage the environment.

The states of the European Union are dependent on the import of fossil fuels from Asian countries, the USA. The governmental committee of European since 1992 tried to implement some strategies for the production of energy from renewable sources. In 2002 at the summit in Johannesburg, the implementation Plan for energy consumption from alternative resources was adopted.

The plan consists ten-year strategies and forecasts, which are directed by the United Nations Environment Programme. Through the Kyoto protocol, the substantial reduction of gas emission emitted by home was adopted. Projects have been implemented by researchers to reduce carbon dioxide emissions. The use of fossil fuels is dangerous because harmful emissions are

released into the atmosphere. Biomass is important because heat is obtained from it.

Among the composite materials, the most common are wood chipboards.

Compared to solid wood, chipboards have the following advantages:

- superior utilization of small-sized varieties (manufacturing leftovers, sawdust, wood dust) and some inferior species (willow, poplar, alder);
- presents uniform thickness;
- have a high dimensional stability;
- have large, flat surfaces with little roughness;
- the degree of anisotropy of the structure is reduced in all directions, due to the division of the wood into chips.

Chipboards also have disadvantages compared to solid wood:

- the faces of these panels don't confer a favorable aesthetic value, for this reason they must be ennobled;
- they have water absorption and a high thickness.

Biomass is one of the most important sources of renewable energy. The supply of energy from biomass has developed since 2000, and in 2010 this field supplied 280 TWh of electricity globally. This electricity is equivalent to 1.5% of the electricity supplied in the world.

Today biomass continues to play an important role in countries that aren't members of the OECD (Organization for Economic Cooperation and Development).

Developing countries ensure their energy needs such as biomass, using thermal plants with a yield lower than 10-50%.

The characteristics of biomass that determine its use as fuel on the energy market are the chemical composition, burning speed, calorific power, burning density, water and ash content.

Biomass, in addition to advantages, also has disadvantages:

- the density of the biomass and the calorific value of woody species is lower compared to that of fossil fuels.
- untreated biomass has a high moisture content, which is the main factor that determines a low heat obtained from the material following combustion processes.

2. Materials and method

There are a number of ways to determine the calorific value for woody species, both experimentally and through empirical equations. In the beginning, the Junkers calorimeter was used, which determines the calorific value for gaseous fuels.

The method consists in the complete combustion of a known entity of gas and the transmission of the heat released in the combustion process to a flow of water that circulates through the calorimeter. The resulting combustion gases are cooled to ambient temperature by a stream of water. The mass of water, the temperature variation, the mass of the condensed vapors from the combustion products

are measured finally thus both the upper and the lower heat are determined.

The calorific value of solid and liquid fuels is measured with the calorimeter bomb. The Berthelot calorimeter is often used (Fig.1). The calorimeter is composed of the following component parts: C-vessel with lid, T₂-thermometer which is inserted into vessel, A-stirrer.

Vessel C has isolated support initial vessel B. The calorimeter works on the principle of mixtures. The calorimeter and the water it takes the heat given off by the studied body (M) until the equilibrium temperature is reached (T_m and T₂).

The process of determining the caloric value of the wood materials refers first of all to the preparation of the raw material and the installation, then to the actual determination and finally to the obtaining of the final result. The preparation of the wood material for testing consists in taking a small part of about 0.6-0.8 grams of the whole material, the sample weighed with an accuracy of 0.0002 g.

The sample must be clean, made of freshly cut wood, because old wood doesn't have all the volatile and flammable substances that could influence its calorific value. This sample is placed in a porcelain crucible and placed in a laboratory oven for drying at a temperature of $103 \pm 2^\circ \text{C}$.

Enter the computer software, complete the type of test (determination or calibration), the name of sample, the mass of the sample, the nickel and cotton thread, as well as other necessary data. Next, the operation of determining the caloric power starts, selecting and activating the "STARTS" button on the computer program displayed on the monitor (Fig. 2). From this moment on the actual test to determine the caloric power begins.

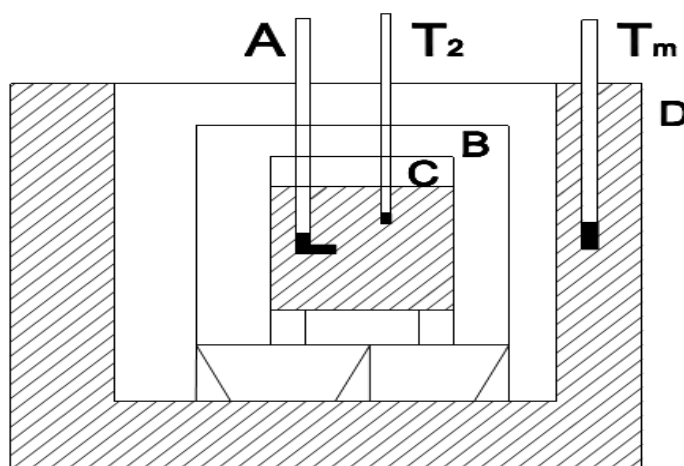


Fig. 1. Berthelot calorimeter

The test contains three different periods, respectively:

- The initial period (fore), which aims to determine the temperature variations, of the water in the calorimeter, due to the exchange of heat with the outside before

burning. During this period, usually 5 minutes, the precision thermocouple temperature is displayed and read minute by minute.

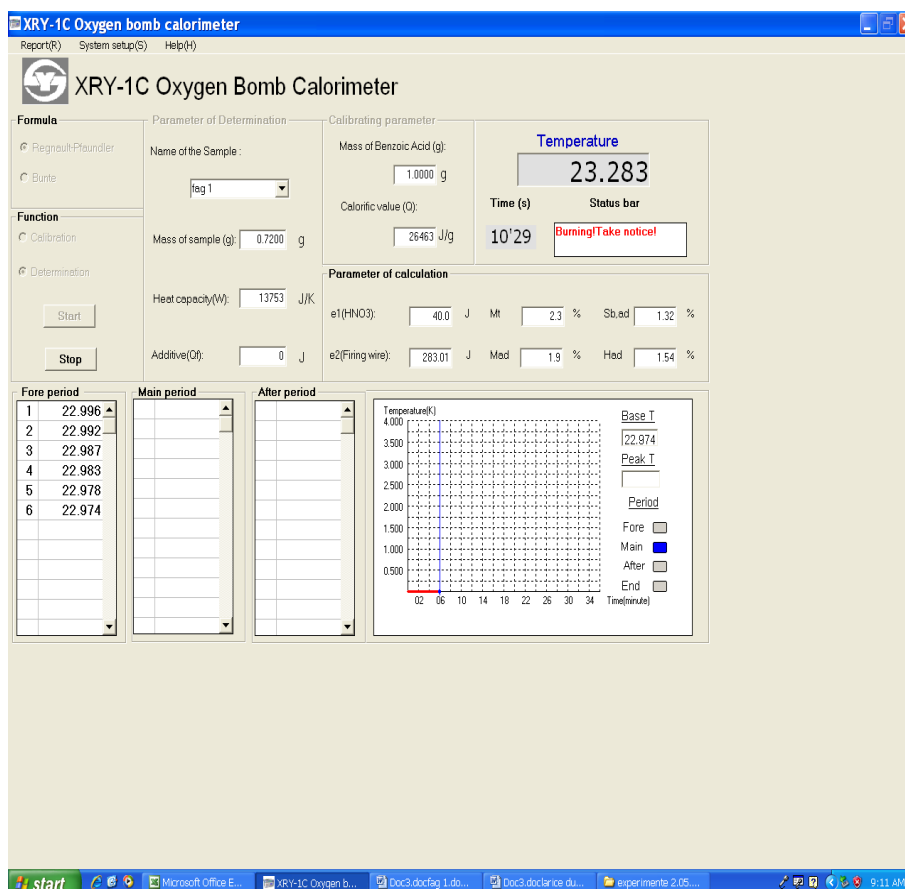


Fig. 2. Description of the process to assess the caloric power

- The main period ("main") begins with the ignition of the sample and has as a consequence the increase of the water temperature in the calorimetric vessel, due to the burning of the wood particle and the emission of heat.

- The final period ("after") aims to determine the average temperature variation of the water in the calorimeter due to the heat exchange with the outside, after combustion

For the chipboards with thickness 3 mm, at U= 0%, m= 0.7790 g, higher caloric power= 18820 kJ/kg, lower caloric power= 18228 kJ/kg,

density= 0.6400 g/cm³, energy yield = 0 %, U= 10%, m= 0.5940 g, higher caloric power= 16184 kJ/kg, lower caloric power= 15756 kJ/kg, density= 0.540 g/cm³, energy yield = 95 %, U= 20%, m= 0.7090 g/cm³, higher caloric power= 13844 kJ/kg, lower caloric power= 12988 kJ/kg, density= 0.644 g/cm³, energy yield = 88 %, U=50%, m= 0.6890 g, higher caloric power= 6824 kJ/kg, lower caloric power= 4684 kJ/kg, density= 0.626 g/cm³, energy yield = 51%.

The variation of the calorific power for OSB is presented in Fig. 3.

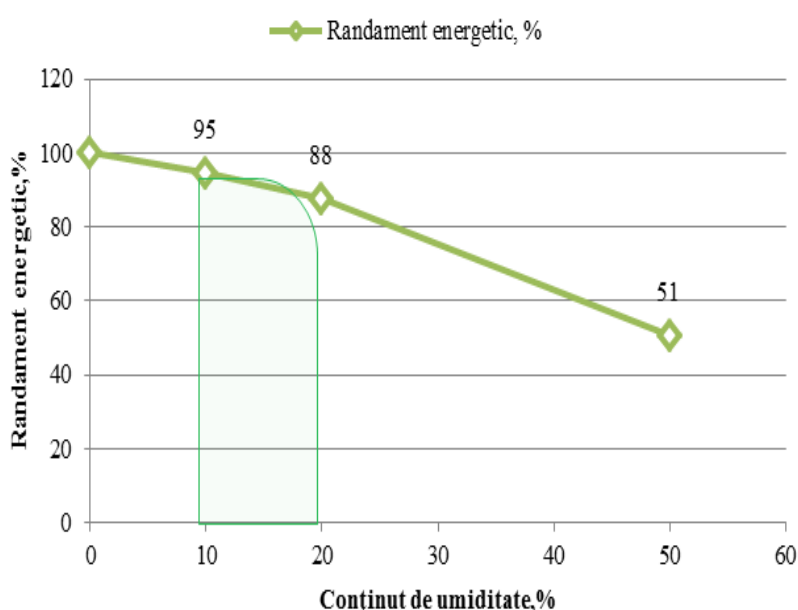


Fig. 3. The variation of the energy yield for chipboard with 3 mm thickness

3. Conclusions

The research carried out in the energy field demonstrates the fact that electricity and heat can be produced from biomass through conversion processes,

Currently, biomass contributes approximately 12% to energy production in the world, and in developing countries it occupies 40-50% of energy supply requirement.

Technologies based on renewable energies generally have a lower impact on the environment than fossil fuel technologies.

In recent years, this sector has registered substantial growth, but efforts will be needed to achieve the essential objectives in production and to encourage the consumer to use this bioenergetic material.

The energy potential of biomass is assessed, in Romania's energy strategy recently relaunched in the debate, at a total of 318000 TJ/year having an equipment of 7.6 million TEP (tons of oil equivalent).

This potential results from: agricultural waste (cereals, corn stalks, plant residues of vines) – 63%, residues from forestry operations and firewood -16 %, residues from livestock farms – 8 %, wood waste- 6 %, urban household waste and residues – 7 %.

References

1. Abassi, S.A, Nipanay, P.C., Schaumberg, G.D. Bioenergy potential of eight common aquatic weeds,

- Biological Wastes, vol.34, No.4, pag.359-366, 1990;
2. Doniță, N., Ceianu, I., Purcelan, S., Beldie, A. *Ecologie forestieră*, Ed. Ceres București, 1977;
 3. Filipovici, J. *Studiul lemnului*, Editura didactică și pedagogică, București, 1984;
 4. Gavrilesco, D. Energy from biomass in pulp and paper mills, *Environmental Engineering and Management Journal*, pag.537-546, 2009;
 5. Juran, M. *Calitatea produselor*, Ed. Tehnică, București, 1973;
 6. Lako J., Hanesok J., Yuzhakova T. Biomass-A source of chemicals and energy for sustainable development, *Environmental Engineering and Management Journal*, vol. 7(5), pp. 499-509, 2009;
 7. Lăzăroiu G, Mihăescu L. Combustion of pitcoal-wood biomass briquettes a boiler test-facility, *Environmental Engineering and Management Journal*, pp 595-601, 2008;
 8. Lunguleasa A. The calorific power of wooden biomass, *Bulletin of the Transilvania University of Brasov-Series II*, vol.2(51), pp.65-70, 2010;
 9. Moya R., Tenorio C. Fuelwood characteristics and its relation with extractives and chemical properties of ten fast-growth species in Costa Rica, *Biomass and Bioenergy*, vol.56, pp.14-21, 2011;
 11. Nielsen NPK, Gardner D. Importance of temperature, moisture content a species for the conversion process of wood residues to fuel pellets, *Wood Fiber* vol.41, pp 414-425;
 12. Prasertsan S., Sajjakulnukit B. Biomass and bioenergy in Thailand: Potential , opportunity and barriers, *Renewable energy* , vol.31 , Nr.5, 2006;
 13. Rahmann A, Masood MA Influence of size and shape in the strength by briquettes, *Fuel Process Technology*, vol.22, pp125-145,2013;
 14. Roser D., Asikainen A. Sustainable use for Forest Biomass for Energy, Springer Series in Wood Science, 2006;
 15. Swithenbank, J, Chen, Q, Zhang, X, Sherif, V., Poukashamiani, M, Wood would burn, *Biomass and bioenrgy*, nr.3, 2011.
 16. Teuch O, Hofeanuer A, Troger F, From J. Basic properties of specific wood based materials carbonised in a nitrogen atmosphere, *Wood Science and Technology*, Springer, vol.38, nr.3, 2004;
 17. Uslu A, Faaji A.P.C, Bergman P.C.A Pre-treatment technologies, and their effect on international bioenergy supply chain logistics. Techno-economic evaluation of torrefaction, fast pyrolysis and pelletisation, *Energy*, vol. 33(8), pp. 1206-1223.

FLORISTIC AND SYNTAXONOMICAL STUDY OF THE DREAT FOREST IN THE PROVINCE OF M'SILA, CENTRAL ALGERIA

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Abstract: For a study on the vegetation of the Dreat forest, located in the chain of Western Hodna in a semi-arid zone of central Algeria. 94 stations were sampled following a subjective sampling during the 4 years 2018-2021 in order to identify the main plant species constituting the floristic procession of these ecosystems. In addition, a classification of phytosociological groups is carried out following statistical analyses (AC, AHC) to study the vegetation as well as a phytosociological typology and syntaxonomic units. This analysis showed a considerable species richness, estimated at around 471 taxa belonging to 284 genera and 66 families. Within the prospected region, the analysis of the raw phytogeographical spectrum indicates a superiority of the Mediterranean group with 259 species. The pluriregional element (or group with a wide distribution) with 114 species occupies the second chorological position followed by the northern element (Nordic group) with 60 species. Finally, the endemics with 38 species. The phytosociological study of the Dreat mountains has revealed ten plant groups belonging to six phytosociological classes : the class of *Quercetea ilicis* Braun-Blanquet 1947, the class of *Rosmarinetea officinalis* Braun-Blanquet 1947 em Rivas Martinez, Diaz, Prieto, Loidi & Penas, 1991, the class *Nerio-Tamaricetea* Braun-Blanquet & Bolos 1956 (1957), the class *Lygeo-Stipetea* Rivas Martinez 1977, em Kaabeche 1990, the class *Tuberarietea guttatae* Braun-Blanquet 1952 em Rivas Martinez 1977 and the class *Stellarietea mediae* R. TX. Lohmeyer & Preising.

Keywords : flora, phytosociology, data analysis, CA, AHC, regressive dynamics.

1. Introduction

Mediterranean forests have a very high heritage value. They unite remarkable reserves of genetic, specific and functional diversity [1]. Among these forest ecosystems, some represent landscapes of global interest [2]. Algeria, by the richness and diversity of its flora which is a reflection of the climatic conditions to which it is adapted and developed constitutes a real phytogenetic and silvicultural reservoir [3], with about 4,000 taxa according to Quezel & Santa (1962-1963); Dobignard & Chatelain (2010-2013) [4,5].

Unfortunately, these true heritages are subject to the combined harmful interventions of different factors, mainly human activities and climate change. For a long time, an ancient and increasingly intense anthropic exploitation for various historical and socio-economic reasons has transformed these ecosystems [6,7,8,9].

The chain of Hodna mountains provides the orographic link between the Biban Mountains and the Aures. It is in this context that we have considered this floristic and phytosociological study at the level of the Dreat Mountains which have not been the subject of any phytosociological study although they represent one of the most important mountains that are notified by an exceptional diversity and a privileged physiognomic structure and an incredible biological context.

2. Materials and methods

Study site

The Dreat forest is part of the chain of Hodna mountains. Administratively, this area is located in the municipality of Hammam Dalaa, the province of M'sila. It is bounded on the north and east by the municipality of Mansoura and the

municipality of Ksour (the province of Bordj Bou Arreridj), in the south by the municipality of Tarmount and west by the municipality of Ouanougha (Fig. 1). It is positioned between the longitudes 04° 11' to 04° 34' E and the latitudes 35° 50' to 36° 01' N.

The municipality of Hammam Dalâa is a mountainous area with very uneven relief and steep slopes. For the classes of exposure, the southern exposure takes up nearly 40% of the total area examined. The main types of soils that lie in the study area are : raw mineral soils, iso-humic soils, calcimagnesian soils, soils little evolved.

The examined region acquires an annual average quantity varying between 298,82mm and 658,58mm. Overall, the sources of rainfall in Algeria are rather orographic. Sequentially, the rainfall changes according to the altitude, exposure and orientation of the mountain ranges [10]. In addition, the average annual temperatures vary from 7.85°C to 26.4°C in the study area. The minimum temperatures are recorded in January for all stations, ranging from -1.58 °C to 3.05°C. For all stations the month of July is the maximum, which ranges from 31°C to 39.2°C.

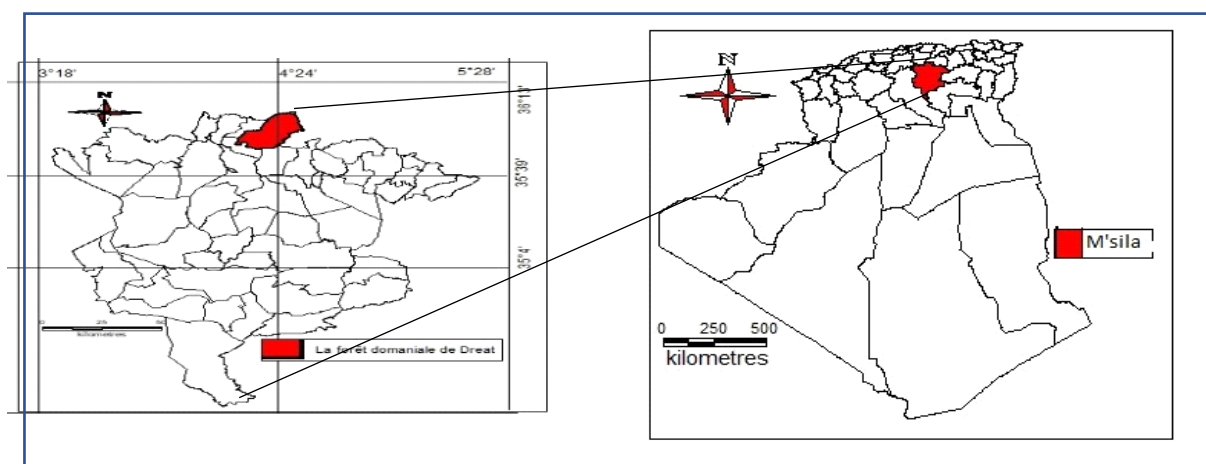


Fig. 1. Geographic location of the Dreat State Forest

Methodology

Data collection

At the level of the Dreat forest, we carried out 94 floristic surveys following the classical sigmatist phytosociological method of Braun-Blanquet. These floristic surveys were executed during the fieldwork of the years 2018-2019-2020-2021 during which we applied a subjective sampling. This sampling plan is adapted while taking into account the structural variations of the vegetation and the criterion of floristic-ecological homogeneity namely altitude, slope, exposure. The surface of the surveys varies according to the types of formation of this fact it varies from 15 m² for the lawns of altitudes, to 50 m² for the steppe vegetation and up to 100 m² for the pre-forest vegetation. In each survey, each species is associated with a coefficient of abundance-dominance according to the abundance-dominance scale of Braun-Blanquet & al. 1952 [11].

The determination of the scientific nomenclature was carried out at the species level

in the field for those easily recognizable and in the laboratory for the unknown and/or doubtful taxa, using the New flora of Algeria and North African flora [4,12].

Data analysis

To process our data, we used the XLSTAT 2016 software. correspondence analysis (CA) and hierarchical clustering analysis (HCA) have among the most commonly used numerical data analysis techniques in various studies on vegetation in North Africa recalling : [13, 14,15, 16, 17, 18, 19, 20, 21, 22]. For all these treatments, only the "presence-absence" character of the species was considered.

3. Results and discussion

The Mediterranean set

This is the largest group, with 258 species. The Mediterranean taxa are similarly dissociated: those linked to the "Mediterranean stricto sensu" phytochoric element number 156 species, followed by the western Mediterranean with 35

species, the Mauritanian Ibero and the Circum-Mediterranean, both with 18 species. The "East Mediterranean" has eight species, the sub-Mediterranean six. North Africa-Sicily 2 (*Brassica amplexicaulis* Desf. var. *triquetrum* Vahl.) Iberian. North Africa 2 (*Carlina racemosa* L. and *Centaurea africana* Lamk. var. *tagana* (Brot.) M. Oro-Mediterranean 2 (*Erinacea anthyllis* Link. and *Alyssum montanum* Desf.). North Africa 2 (*Rhaponticum acaule* (L.) DC and *Hypochaeris radicata* L.). The other elements are represented by a single species.

Nordic set

This set is basically made up of 28 Eurasian taxa. The latter form the major floristic element of temperate regions; they determine a crucial place in the north of the Mediterranean. In second position, paleo-temperate species, which include a large number, 19 species; monitoring of the circumboreal element with 7 species; then comes the paleo-subtropical 5 species. Finally, the European and tropical type elements, respectively, denote 2 and 1 single taxa.

Widespread distribution set

Species with a wide distribution correspond to transitional elements between the Mediterranean set and nearby sets. The Euro-Mediterranean group has the most species (26),

followed by Cosmopolitan (12), Mediterranean-Atlantic (11), and Mediterranean-Touranian (11), which explains the steppe influence on this area. The presence of the Saharan element species shows the Saharan influence on this region. The other batches are presented with fewer than five species.

Endemic set

The endemic species mark this site well with 38 species, i.e., a rate of 8.06% of the determined species (471). Vela and Benhouhou (2007) mention 407 endemic species for northern Algeria, 9.33% of which are found in the explored area. They are subdivided as follows: 7 are assessed as strictly endemic to Algeria (i.e., 1.48%) [23]. The other taxa are evaluated as regional endemics, including 24 North Africans, 3 Algerian-Moroccans and 4 Algerian-Tunisians.

18 families are considered by the endemism of which most of the species are attached to the Asteraceae with 9 species, then come the Lamiaceae with 7 species, the Fabaceae 5 species, the Brassicaceae 3 species. The other families (14 families) have only one taxa (Liliaceae, Oleaceae, Plantaginaceae, Iridaceae, Crassulaceae, Araliaceae, Poaceae, Violaceae, Rubiaceae, Anacardiaceae, Geraniaceae, Apiaceae, Cistaceae and Hyacinthaceae).

Table 1. List of endemic species found in the Dreat forest

Family	Taxa according to Dobignard & Chatelain	Taxa according to Quezel & Santa	Chorological types
Liliaceae	<i>Gagea granatellii</i> (Parl.) Parl.	<i>Gagea granatellii</i> (Parl.) Parl.	Endemic to Algeria
Lamiaceae	<i>Thymus dreatensis</i> Batt.	<i>Thymus dreatensis</i> Batt.	Endemic to Algeria
Lamiaceae	<i>Stachys guyoniana</i> de Noé	<i>Stachys guyoniana</i> de Noé	Endemic to Algeria
Lamiaceae	<i>Rosmarinus eriocalyx</i> Jord. & Fourr.	<i>Rosmarinus tournefortii</i> de Noé	Endemic to Algeria
Fabaceae	<i>Genista ulicina</i> Spach.	<i>Genista ulicina</i> Spach.	Endemic to Algeria
Fabaceae	<i>Hedysarum naudinianum</i> Coss. & Durieu	<i>Hedysarum naudinianum</i> L. (Coss)	Endemic to Algeria
Astéraceae	<i>Pseudopodospermum brevicaulis</i> (Vahl) Zaika, Sukhor. & N. Kilian	<i>Scorzonera coronopifolia</i> Desf.	Endemic to Algeria
Lamiaceae	<i>Origanum vulgare</i> subsp. <i>glandulosum</i> (Desf.) Ietsw.	<i>Origanum glandulosum</i> Desf.	Algerian–Tunisian endemics
Astéraceae	<i>Hertia cheirifolia</i> (L.) Kuntze	<i>Hertia cheirifolia</i> (L.) Kuntze	Algerian–Tunisian endemics
Astéraceae	<i>Centaurea microcarpa</i> Coss. & Dur.	<i>Centaurea microcarpa</i> Coss. & Dur.	Algerian–Tunisian endemics
Araliaceae	<i>Hedera algeriensis</i> L.	<i>Hedera algeriensis</i> Hibberd	Algerian–Tunisian endemics

Oléaceae	<i>Fraxinus dimorpha</i> Coss. & Durieu	<i>Fraxinus xanthoxyloides</i> Wall.	Algerian–Moroccan endemics
Astéraceae	<i>Evacidium discolor</i> (DC.) Maire	<i>Evax discolor</i> DC.	Algerian–Moroccan endemics
Astéraceae	<i>Catananche montana</i> Coss.	<i>Catananche montana</i> Coss.	Algerian–Moroccan endemics
Violaceae	<i>Viola munbyana</i> Boiss. et Reut.	<i>Viola gracilis</i> var. <i>munbyana</i> (Boiss. & Reut.) Batt.	Endemic to North Africa
Rubiaceae	<i>Galium tunetanum</i> Lam.	<i>Galium tunetanum</i> Poiret.	Endemic to North Africa
Astéraceae	<i>Helminthotheca glomerata</i> (Pomel) Greuter	<i>Picris duriaei</i> Sch.Bip	Endemic to North Africa
Lamiaceae	<i>Thymus pallescens</i> Noé.	<i>Thymus fontanesii</i> Boiss. & Reut.	Endemic to North Africa
Iridaceae	<i>Iris unguicularis</i> Poir.	<i>Iris unguicularis</i> Poir.	Endemic to North Africa
Crassulaceae	<i>Sedum pubescens</i> Vahl.	<i>Sedum pubescens</i> Vahl.	Endemic to North Africa
Astéraceae	<i>Centaurea parviflora</i> Desf.	<i>Centaurea parviflora</i> Desf.	Endemic to North Africa
Astéraceae	<i>Centaurea acaulis</i> L.	<i>Centaurea acaulis</i> L. p.p.	Endemic to North Africa
Poaceae	<i>Festuca atlantica</i> Duval-Jouve	<i>Festuca atlantica</i> Duval-Jouve	Endemic to North Africa
Astéraceae	<i>Centaurea involucrata</i> (Desf.) Talavera	<i>Centaurea involucrata</i> Desf.	Endemic to North Africa
Plantaginaceae	<i>Anarrhinum fruticosum</i> Desf.	<i>Anarrhinum fruticosum</i> Desf.	Endemic to North Africa
Lamiaceae	<i>Thymus algeriensis</i> Boiss. & Reut.	<i>Thymus algeriensis</i> Boiss. & Reut.	Endemic to North Africa
Lamiaceae	<i>Thymus munbyanus</i> Boiss. & Reut.	<i>Thymus ciliatus</i> subsp. <i>eu-ciliatus</i> Maire.	Endemic to North Africa
Anacardiaceae	<i>Pistacia atlantica</i> Desf	<i>Pistacia atlantica</i> Desf	Endemic to North Africa
Geraniaceae	<i>Erodium crassifolium</i> Forssk.	<i>Erodium hirtum</i> Desf.	Endemic to North Africa
Fabaceae	<i>Genista tricuspidata</i> Desf.	<i>Genista tricuspidata</i> Desf	Endemic to North Africa
Fabaceae	<i>Ebenus pinnata</i> L.	<i>Ebenus pinnata</i> L.	Endemic to North Africa
Fabaceae	<i>Astragalus armatus</i> Willd. subsp. <i>armatus</i>	<i>Astragalus armatus</i> Willd	Endemic to North Africa
Apiaceae	<i>Deverra scoparia</i> Coss. & Durieu	<i>Pituranthos scoparius</i> (Coss et Dur) Benth & Hook	Endemic to North Africa
Cistaceae	<i>Helianthemum helianthemoides</i> (Desf.) Grosser	<i>Helianthemum helianthemoides</i> Desf.	Endemic to North Africa
Brassicaceae	<i>Psychine stylosa</i> Desf.	<i>Psychine stylosa</i> Desf.	Endemic to North Africa
Brassicaceae	<i>Biscutella raphanifolia</i> Poir.	<i>Biscutella raphanifolia</i> Poiret.	Endemic to North Africa
Hyacinthaceae	<i>Bellevallia mauritanica</i> Pomel.	<i>Bellevallia mauritanica</i> Pomel.	Endemic to North Africa
Brassicaceae	<i>Alyssum scutigerum</i> Dur.	<i>Alyssum scutigerum</i> Dur.	Endemic to North Africa

Discrimination of plant communities by numerical analyses

Table 2 shows the first 4 axes which absorb 19.42% of the total variance. The eigenvalues for axis 1 are high (0.632), and they drop off significantly after axis 2 to a relatively low level.

Given that the first three axes- axis 1, axis 2, and axis 3- alone account for roughly 16% of the overall variance, the inertia rates remain fairly close after axis 3.

Table 2. Overall analysis: eigenvalues and inertia rates of the main axes

Total inertia: 10,125			
	Eigenvalue	Inertia %.	Cumulative
F1	0,632	6,247	6,247
F2	0,494	4,874	11,121
F3	0,439	4,336	15,457
F4	0,402	3,969	19,426

We have limited our interpretation of the results to these three axes. Axis 1 clearly opposes the herbaceous formations of the high grassland type in the positive part to the formations of the low matorral type that occupy the negative part of the axis, a gradient of physiognomic structural order is expressed by this axis. Axis 2 determines a gradient of degradation (regressive evolution) to the we have retained the species of arid pastures where human and animal intervention reaches its maximum on these low altitudes and these low slopes (15 to 30%) such as: *Plantago albicans*,

Filago spathulata, *Phalaris truncata*, *Artemisia herba-alba*, *Psychine stylosa*, *Helianthemum virgatum*, *Salvia verbenaca*, *Medicago truncatula* and *Hypochoeris achyrophorus*. Axis 3 represents a gradient of moisture that is associated to altitude by expressing the opposition of the habitats Oued-steppe. Additionally, the dendrogram representation of the hierarchical clustering analysis (HCA) data reveals that there are three main clusters among the 94 floristic surveys based on Pearson dissimilarity

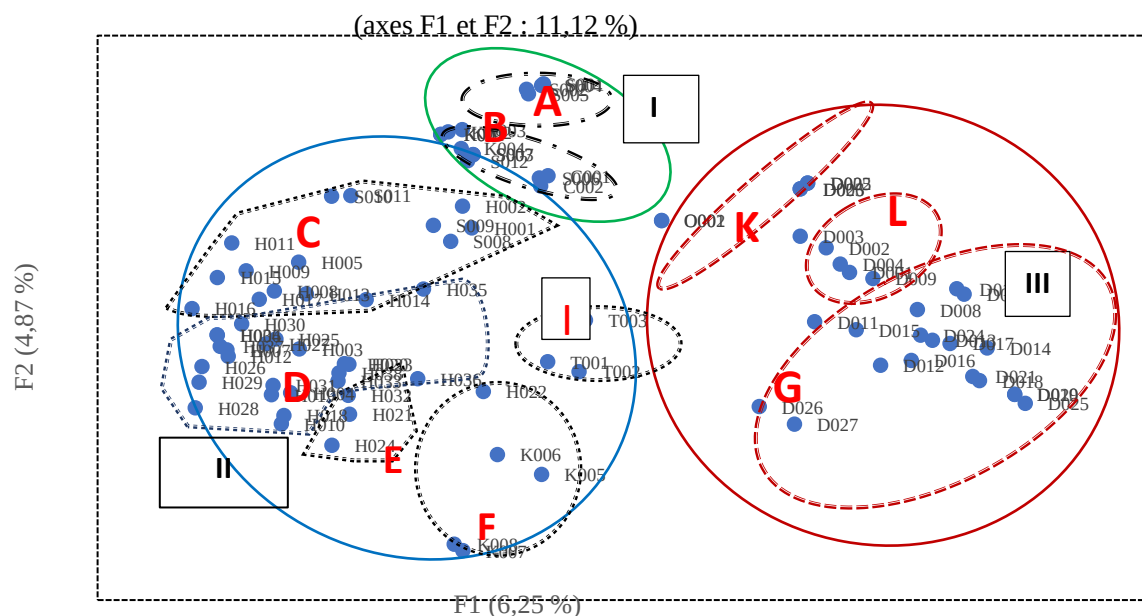


Fig. 2. Ordination diagram (correspondence analysis) of the data matrix of Dreat forests (94 relevés x 231 species)

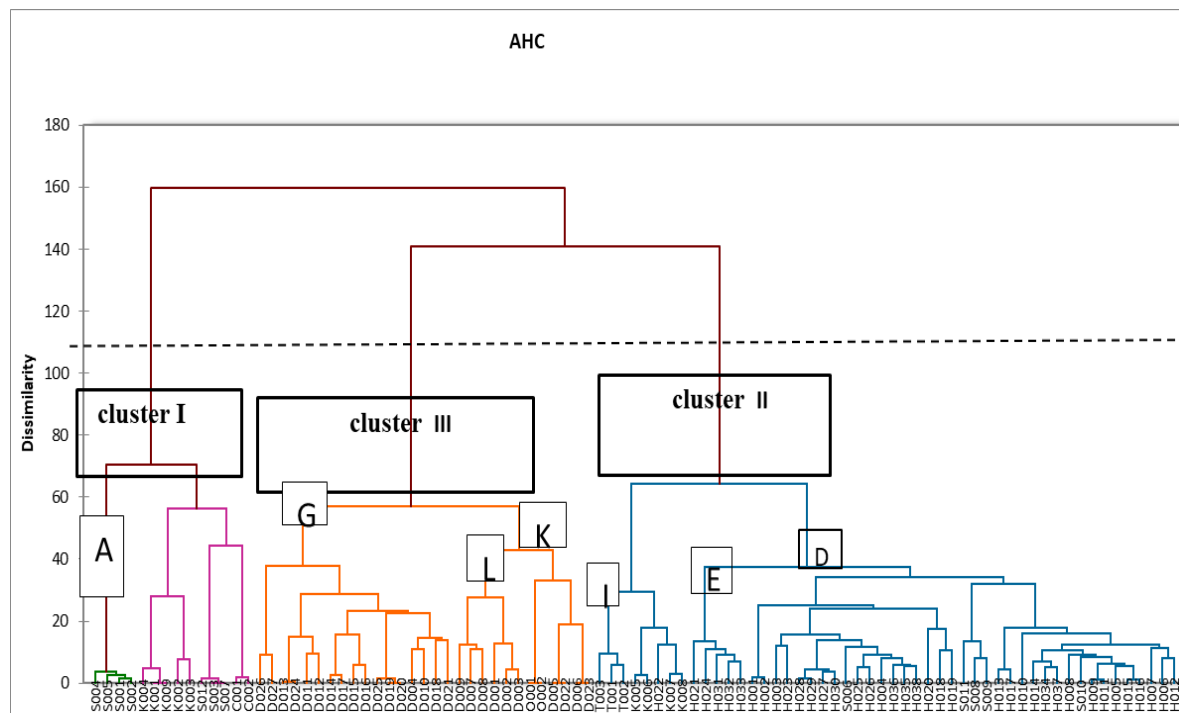


Fig. 3. Dendrogram of the hierarchical clustering based on of Pearson dissimilarity of the data matrix of Dreat forests (94 relevés x 231 species). Three clusters (A, B, C and D) are highlighted.

Syntaxonomic and synecological interpretation of Dreat plant communities

The numerical analysis (multivariate CA+AHC) of our data, which included information from 94 surveys and 231 species (out of a total of 333 taxa, to which we limited 102 species that were present just once), allowed us to identify 10 floristic communities, which are highlighted in the following syntaxonomic scheme :

- **Quercetea ilicis** Br-BI 1936, 1947

Pistacio-Rhamnetalia alaterni Rivas-Martinez 1975

Quercus ilex & *Juniperus phoenicea* community
Juniperus phoenicea & *Rosmarinus tournefortii* community

Genisto tricuspidatae-Calicotomion spinosae
 Dahmani 1997 [24]

Calicotomo spinosae-Quercetum rotundifoliae
 Dahmani 1997

Alliance Calicotome spinosa and Thymus ciliatus Gharzouli 1989 [16]

Calicotetosum spinosae sub-asso.

- **Rosmarinetea officinalis** Rivaz-martinez, t.e. diaz, f. prieto, loidi & penas 1991

Erinacetalia anthyllidis Quézel 1957

Alyso serpyllifoliae-Onosmion fastigiatae
 Gharzouli 2007 [25]

Silene colorata & *Kentranthus calcitrapa* community

Nerio oleandri - Tamaricetea africanae Braun-Blanq & O. Bolès 1958[26]

Tamaricetalia Br-BI & Bolos 1957

Tamaricion africanae Br-BI & Bolos 1957

Nerium oleander community

Tuberarietea guttatae Braun-Blanquet 1952 em. Rivas-Martinez 1978 [11]

Brachypodietalia distachyae Rivas-Martinez 1978 em. Kaabèche 1990[27]

Filago spathulata & *Scorpiurus muricatus* community

- **Stellarietea mediae** Tüxen, Lohmeyer & Preising in R. Tüxen 1950

Alliance Launaeion nudicaulis El Antri 1983

Artemisia herba-alba & *Eryngium campestre* community

Lygeo-Stipetea Riv.-Mart 1977, em Kaabeche 1990 [27]

Stipetalia tenacissimae

Stipa tenacissima & *Juniperus phoenicea* community

Alliance Artemisia herba alba and Plantago albicans Djebaili 1978 [28]

Medicago minima & *Aizoon hispanicum* community.

***Quercus ilex* & *Juniperus phoenicea* community**

This community refers to a degraded matorral that is dominated by several species, including *Quercus ilex*, *Juniperus phoenicea*, *Phillyrea angustifolia*, and *Pistacia lentiscus*. These pre-forest formations are located on the ridges of the djebels Kef El Assel, Chedoug and Sidi Amar at altitudes ranging between 770m and 1600m with a global coverage between 40% and 80%. The described grouping is observed on the northern, eastern and southern exposures and it is distributed on uneven grounds to the slope exceeds the 20%.

Additionally This community can be classified into 3 subgroups, most of which reflects changes mainly connected to ecological and anthropogenic influences.

- A subgroup dominated by *Phillyrea angustifolia*, associated with *Scabiosa stellata* and *Rosmarinus tournefortii*. This low matorral is principally marked by an opening lighted by a high rate of therophytes and a poverty at the level of specific richness justified by the adverse climatic conditions of the south slope.
- A degraded subgroup with *Asparagus albus*, *Thymus algeriensis* and large clumps of umbellifers of *Pituranthos scoparius*, indicating the steppe aspect and desert grazing that was observed mainly on calcimagnesian soil in the area of djebel Chedoug
- A subgroup in the canton of Kef El Assel that includes *Ornithogalum umbellatum*, *Asphodelus microcarpus*, and *Alyssum granatense*, indicating trampled and grazed habitats.

The abundance of these characteristics taxa : *Quercus ilex*, *Juniperus phoenicea*, *Phillyrea angustifolia*, *Pistacia lentiscus*, *Jasminum fruticans*, *Ampelodesma mauritanicum* et *Cistus albidus* justifies the classification of the community in the *Pistacio-Rhamnetalia alaterni* Riv-Mart 1975 order of the class *Quercetea ilicis* Br-BI 1947 (Tab. Phyto 1).

The analysis of biogeographical types clearly shows the predominance of the Mediterranean strain with 55%. The spectrum of the biological form shows that therophytes represent 55%, this rate reflects a degree of openness in this formation

due to the presence of species of *Tuberarietea guttatae*, stimulated by overgrazing.

The association Calicotomo spinosae-

***Quercetum rotundifoliae Dahmani* 1997 [24]**

This grouping corresponds to a low matorral located on the northern flank of the township of Sidi Amar. It is expressed with a global coverage between 60 and 80%, it is located between 1000m and 1600m altitude on uneven ground (P3). In addition the biological spectrum reflects a remarkable level of openings of the grouping with the predominance of therophytes (53%). The latter primarily belong to the classes *Stellarietea mediae* and *Tuberarietea guttatae*.

Moreover, the existence of these characteristics : *Quercus ilex*, *Genista tricuspidata*, *Calycotome spinosa*, *Juniperus oxycedrus* and *Ampelodesma mauritanicum*, allow us to attach it to the association *Calicotomo spinosae-Quercetum rotundifoliae* Dahmani 1997, to the alliance *Genista tricuspidatae-Calicotomion spinosae* ; to the order of the *Pistacio-Rhamnetalia alaterni* Riv.Mart 1975 and to the class *Quercetea ilicis* Braun-Blanquet 1947 (Tab. Phyto 2).

***Juniperus phoenicea* & *Rosmarinus tournefortii* community**

This community is located in the canton of El Haourane and corresponds to a vegetation dominated by *Juniperus phoenicea*, *Pistacia lentiscus*, *Rosmarinus tournefortii* and *Stipa tenacissima*, it is noted with a 60 to 80% global coverage. The reported group is situated between an altitude of 900m and 1590m at various exposures (north, east, west, and south). There are 17% phanerophytes in this middle matorral. Therophytes make up 46% of the herbaceous layer, followed by hemicryptophytes with 18%, and geophytes with 10%.

Due to the presence of several traits of *Quercetea ilicis* (Braun-Blanquet 1947), including *Quercus ilex*, *Phillyrea angustifolia*, *Olea europaea*, and *Juniperus phoenicea*, this grouping has been included in that class. Additionally, this community has similarities with the d'alfa, holm oak, and juniper variation identified in Algeria by Aidoud (1984) [29]

In addition, the floristic research confirms that this holm oak forest exhibits a regressive dynamic (champhitization) due to the invasion of species of the class *Lygeo-Stipetea*, particularly the alfa and

white wormwood, as well as the presence of many taxa of *Cisto-Rosmarinetea* (Tab. Phyto 3).

The aforementioned group is home to endangered and endemic species such as : *Asparagus officinalis* L. *Spartium junceum* L. *Alyssum scutigerum* Dur. *Erodium hirtum* Desf. *Rosmarinus tournefortii* de Noé (= *Rosmarinus eriocalyx* Jordanet Fournier), *Gagea granatellii* Parl, *Ebenus pinnata* L and *Centaurea acaulis* L.

***Juniperus phoenicea* & *Stipa tenacissima* community**

This community is a tree steppe dominated by Esparto grass, white wormwood and the Phoenician juniper. It is indicated with a global coverage between 40% and 60%, slopes ranging from 12.5% to 50%, and altitudes between 840 and 1100 meters. This formation can be found in El Haourane's southern, northern, and western exposures.

In actuality, this formation can also be split into four varieties, all of which are clearly linked to anthropogenic factors :

- A variation of *Pistacia lentiscus* and *Olea europaea*, this natural pistachio forest exhibits more or less deteriorated pre-forest groups.
- A variant of *Pinus halepensis*, which likewise reflects a pre-forest group where Aleppo pine predominates over esparto grass.
- A *Globularia alypum* variant, showing a significant opening in the vegetative coverage.
- A variation with *Launaea acanthoclada* and *Asparagus albus* that ensures the transition to xerophyte groups.

Furthermore, this grouping indicates a stage of holm oak forest degradation, which is supported by the traits of *Quercetea ilicis*, which includes *Juniperus phoenicea*, *Asparagus albus*, and *Pistacia lentiscus*, and *Rosmarinetea officinalis*, which includes *Teucrium pseudo-chamaepestis*, *Teucrium polium* and *Rosmarinus tournefortii* (Tab. Phyto 4).

Due to the prevalence of these traits : *Stipa tenacissima*, *Artemisia herba alba*, *Matthiola fruticulosa*, *Plantago albicans*, *Salvia verbenaca*, *Paronychia argentea* and *Helianthemum virgatum*, this community is associated to the class *Lygeo-Stipetea* and the order *Stipetalia tenacissimae* Riv-Mart 1977, em Kaabeche 1990 [27].

***Nerium oleander* community**

The oleander species occurs frequently in this group. It exists in Oued El Haourane, on the southern exposures of the canton of El Haourane, at an altitude of 900 meters and shows a weak global coverage between 30 and 40%. According to the syntaxonomic analysis, This community is simply included in the class of *Nerio oleandri* - *Tamaricetea africanae* Braun-Blanquet & Bolès 1958, these southern Mediterranean formations are common throughout North Africa (Bensettiti 1995) [30].

Nerium oleander, *Ampelodesma mauritanica*, *Juncus acutus* and *Tamarix africana* are a few examples of the traits of the supper units (alliance, order : *Tamaricion africanae* Br-Bl & Bolos 1957 and *Tamaricetalia* Br-Bl & Bolos 1957).

Moreover, Additionally, this Oleander thicket's floral cortege is characterized essentially by the presence of representatives of the classes : *Quercetea ilicis* Br-Bl 1947 (*Juniperus phoenicea*, *Pistacia lentiscus*, *Phillyrea angustifolia*) ; *Rosmarinetea officinalis* Br-Bl 1947 (*Rosmarinus tournefortii*, *Globularia alypum*, *Astragalus armatus*) and *Lygeo-Stipetea* Riv-Mart 1977, em Kaabeche 1990 [27]

(*Artemisia herba alba*, *Stipa tenacissima*) (Tab. Phyto 5)

***Artemisia herba-alba* & *Eryngium campestre* community**

This community is an anthropogenic steppe that includes therophytic communities with a nitrophilic character of soils heavily modified by Kaabache, 1990 [27]. This group is located between 900 and 1200 meters above sea level on the western slopes of djebel Kef El Assal. Floristically, it is differentiated by the dominance of *Artemisia herba-alba* and *Eryngium campestre*.

The *Stellarietea mediae* Tüxen, Lohmeyer, and Preising in R. Tüxen 1950 species are even more syntaxonomically represented than the *Tuberarietea guttatae* Braun-Blanquet species. As either a result, we classify these steppes as belonging to the first class and, specifically, to the alliance *Launaeion nudicaulis* described by El Antri (1983). *Phalaris minor*, *Psychine stylosa*, *Anacyclus tomentosus*, *Eruca vesicaria*, *Calendula aegyptiaca*, *Hypochoeris aetnensis*, *Aizoon hispanicum*, *Reseda alba* and *Sonchus oleraceus* are among the plants that make up this combination (Tab. Phyto 6).

***Medicago minima* & *Aizoon hispanicum* community**

Physiognomically, this community belongs to a Chamephytic steppe that is predominantly defined by the dominance of *Artemisia herba-alba*, *Medicago minima* and *Aizoon hispanicum*. On the western exposures of the djebel Tihor, the mentioned group is located. With a global covering of between 50% and 70%, it is situated at an average altitude that fluctuates between 715m and 730m.

The attachment of this group to the *Lygeo-Stipetea* Rivas-Martinez 1978 em. Kaabeche 1990 [27]

, to the *Stipetalia tenacissimae* and to the Alliance *Artemisia herba alba* and *Plantago albicans* Djebaili 1978 seems obvious because of the abundance of the representatives of these higher units such as : *Artemisia herba-alba*, *Plantago albicans*, *Medicago minima*, *Aizoon hispanicum*, *Scorzonera undulata*, *Euphorbia falcata*, *Paronychia argentea*, *Helianthemum hirtum*, *Lygeum spartum*, *Stipa tenacissima*, *Allium cupani* and *Atractylis carduus*.

The sub-association of *Calicotetosum spinosae*

The sub-association of *Calicotetosum spinosae* is a low matorrals resulting from the ultimate degradation of holm oak woodlands. It is characterized by the dominance of calicotome and diss. It occurs with a 40–80% global coverage and is situated between 1390 and 1570 meters above sea level in the southern exposures of the djebel Mansour.

This community, which has been identified by 16 relevés, belongs under the syntax categories of the class *Quercetalia ilicis*, the order *Pistacio-Rhamnetalia alaterni*, the alliance of *Calicotome spinosa* and more specifically the sub-association of *Calicotetosum spinosae*. Some of the diagnostic species of this sub-association include *Avena sterilis*, *Inula viscosa*, *Plantago major*, *Carduus nutans* and *Trifolium pratense*.

The significant prevalence of *Rosmarinetea* and *Erinacetalia* species (*Thymus dreatensis*, *Helianthemum croceum*, *Helianthemum cinerum*, *Astragalus armatus*, *Teucrium polium* and *Knautia arvensis*) inside this sub-association attests to a regressive evolution brought on by an excessive anthropozoic action. Our research area's richness of these taxa revealed how this development exhausted these formations and gave rise to open groupings (*Tuberarietea*) : *Aegilops*

triuncialis, *Anacyclus clavatus*, *Aegilops ventricosa*, *Echinaria capitata*, *Eryngium triquetrum* and *Filago spathulata* (Tab. Phyto 8).

***Filago spathulata* & *Scorpiurus muricatus* community**

Filago spathulata and *Scorpiurus muricatus* are the dominant plants in this community of grassland. The last one is located in the southern exposures of djebel Mansour and northern canton of Belouadeh, it is expressed with a coverage estimated between 40% and 60% on slopes varying between 12.5% and 50% and an altitude included between 990m and 1600m.

Due to these of diagnostic species : *Filago spathulata*, *Scorpiurus muricatus*, *Eruca vesicaria* and *Micropus bombycinus* we classified these grassland to The class of *Tuberarietea guttatae* and more precisely to the order of *Brachypodietalia distachyae* Br.-Bl. 1952 em Rivaz-Martinez 1977 (Tab. Phyto 9).

***Silene colorata* & *Kentranthus calcitrapa* community**

These lawns are located between 1500 and 1560 m, with a global coverage of between 40% and 80%. It is situated on uneven ground (12.5–50%) on the southern exposures of the djebel Mansour. These communities are characterized by only one taxa in shrub layer that is the sub-shrubs *Calicotome spinosa* (L.) the dominance of the herbaceous stratum composed mainly of therophytes and hemicryptophytes (e.g *Silene colorata*, *Anthyllis vulneraria*, *Bromus tectorum*, *Kentranthus calcitrapa*, *Alyssum granatense* and *Asperula hirsuta*) that represent respectively a rate of 48% and 36%.

The floristic and syntaxonomic analysis of this grouping, which corresponds to high lawns, shows the predominance of species characteristic of *Rosmarinetea officinalis* Rivaz-Martínez, T.E. Diàz, F. Prieto, Loidi & Penas 1991 and *Erinacetalia anthyllidis* Quezel 1957, such as : *Knautia arvensis*, *Anthyllis vulneraria*, *Asperula hirsuta*, *Thymus dreatensis*, *Pallenis spinosa* , *Ornithogalum umbellatum*, *Valeriana tuberosa*, *Astragalus armatus* , *Jurinea humilis* and *Catananche caerulea*, which allowed to integrate it to this class and more specifically to Alliance-*Alyso serpyllifoliae-Onosmion fastigiatae* described by Gharzouli (1989) [16] to define the grouping located below 1800m represented by *Helianthemum cinerum*, *Sedum acre*,

Helianthemum helianthemoides and *Tulipa sylvestris* (Tab. Phyto 10).

In addition, the characteristics of *Quercetea ilicis* : *Calycotome spinosa*, *Ampelodesma mauritanicum* and *Thapsia garganica* show that this grouping is the result of a degradation of low matorrals with calicotome and diss. This regressive dynamic contributes to the installation of the transgressives of *Tuberarietea Guttatae* and *Stellarietea mediae*. In this community the class of *Molinio-arhenareteretea* is represented by three elements *Lotus corniculatus*, *Dactylis glomerata* and *Plantago lanceolata*. According to Boulaacheb (2009) [13], these formations are much more related to grazing and therefore reflect overgrazed lawns.

These findings justify the absence of a climatic forest, the increased phenomenon of desertification marked essentially at the level of djebel Tihor and on the southern flanks of djebel Chedoug, the extension of plant formations with thorny xerophytes in the steppe ecosystems and the ermes in the pre-forest environments and the grasslands of altitudes. Therefore, we believe that the implementation of a management strategy based primarily on the control of grazing and rehabilitation of these courses that host many endemic and rare species of heritage interest for Algeria would help to ensure better protection and more effective management for these mountains.

Conclusion

The analysis of the floristic diversity of the Monts de Dreat reveals a rich and diversified flora (more than 470 species) which belongs to 284 genera and 66 families of vascular plants. The Asteraceae, Fabaceae, Poaceae, Brassicaceae, and Lamiaceae families are the most well-represented at both the specific and generic levels. Many endangered and rare species are included in the floristic list, particularly those from the Orchidaceae family, which consists of 10 taxa and three genera (*Androrchis*, *Orchis*, *Ophrys*).

The phytosociological study of the vegetation of the Dreat mountains has allowed us to discriminate 10 plant groups under the five main physiognomic types (forests, matorrals, steppe, grasslands and riparian). Indeed, Dreat area presents a regressive evolution due to several factors including : anthropozoic activities in particular at the level of the lawns of djebel Mansour which lead to a very rapid change in the

physiognomy of these territories or these grasslands have been dominated by asphodel under the effect of overgrazing

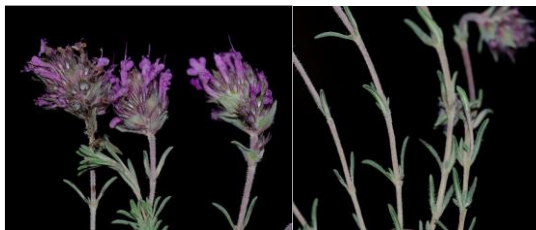
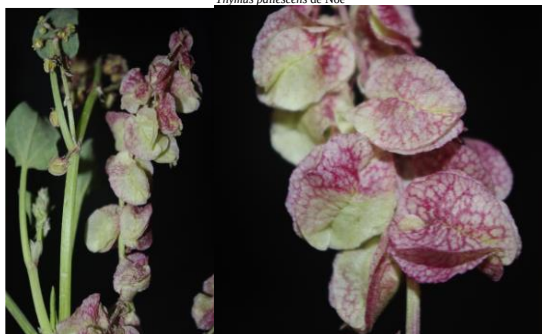
The illegal cutting of trees are little noticed unlike the collection of herbs for therapeutic purposes is widely responded. Still is added the fires that are major factors in the regression of the plant carpet especially for the southern slope of Kef El Assal which has experienced fires during the year 2013. The effect of these factors has been accentuated by the periodic drought as well as the southern winds that act on the regeneration of most plant species.

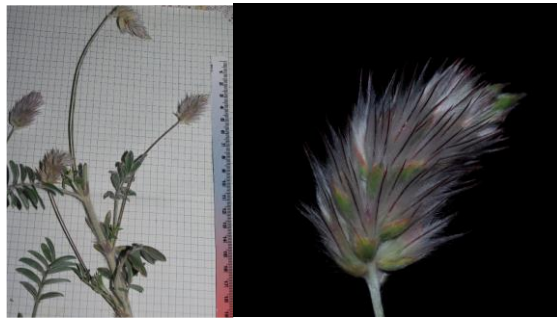
References

1. Quezel, P., Médail, F.: *Ecologie et biogéographie des forêts du bassin méditerranéen*. Elsevier. 2003;
2. Benabadji, N., Benmansour, D., Bouazza, M.: *La flore des monts d'Ain Fezza dans l'ouest algérien, biodiversité et dynamique*. Sciences & Technologie. C, Biotechnologies. 2007, p. 47-59;
3. Tassin, C. : *Paysages végétaux du domaine méditerranéen : Bassin méditerranéen, Californie, Chili central, Afrique du Sud, Australie méridionale*. Marseille. 2012;
4. Quezel, P. & Santa, S.: *Nouvelle flore de l'Algérie et des régions désertiques méridionales*. Paris. 1962-1963;
5. Dobignard, A., Chatelain, C.: *Index synonymique et bibliographique de la Flore d'Afrique du Nord*. Genève. 2010-2013;
6. Aidoud, A.: *Contribution à l'étude des écosystèmes steppiques du sud-oranais, phytomasse; production primaire et applications pastorales*. Thèse de 3^{ème} cycle. Université Science Technologie Houari Boumediene, Alger. 1983, 180 p.;
7. Aidoud, A.: *Les écosystèmes steppiques pâturés d'Algérie: fonctionnement, évaluation et dynamique des ressources végétales*. Thèse de doctorat. Université Science Technologie Houari Boumediene, Alger. 1989;
8. Kadi-Hanifi-Achour, H.: *L'alfa en Algérie. Syntaxonomie, relation milieu-végétation, dynamique et perspectives d'avenir*. Thèse de doctorat. Université Science Technologie Houari Boumediene, Alger. 1998;
9. Quezel, P., Barbero, M.: *Variations climatiques au Sahara et en Afrique sèche depuis le Pliocène: enseignements de la flore et de la végétation actuelles*. Bull. Eco. 24, 1993, p. 191-202;

10. Seltzer, P.: *Le climat de l'Algérie*. INST. Météor Et de phys du globe. Univ. Alger. 1946;
11. Braun-Blanquet, J, Roussine, N., Nègre, R.: *Groupements végétaux de la France méditerranéenne*. 1952;
12. Maire R.: *Flore de l'Afrique du Nord (Maroc, Algérie, Tunisie, Tripolitaine, Cyrénaïque, Sahara)*. Lechevalier. Paris. 1952-1987;
13. Boulaacheb, N. 2009: *Etude de la végétation terrestre et aquatique du djebel Megriss (Nord Tellien, Algérie) Analyse floristique, phytosociologique et pastorale*. Thèse de doctorat. Université Ferhat Abbas, Sétif;
14. Achoubi, L.: *Etude phytosociologique et phytoecologique des formations à pin d'ALEP de l'étage bioclimatique semi-aride Algérien*. Thèse de doctorat. Université Science Technologie Houari Boumediene, Alger. 2005;
15. Yahi, N.: *Les cédraies d'Algérie: phytoécologie, phytosociologie, dynamique et conservation des peuplements*. Thèse de doctorat. Université Science Technologie Houari Boumediene, Alger. 2007;
16. Gharzouli, R.: *Contribution à l'étude de la végétation de la chaîne des Babors (analyse phytosociologique des Djebels Babor et Tababort)*. Thèse de Magister. Université Ferhat Abbas, Sétif. 1989;
17. Meddour, R.: *Bioclimatologie, phytogéographie et phytosociologie en Algérie*. Thèse de doctorat. Université Mouloud Mammeri, Tizi-Ouzou. 2010;
18. Rebbas, K., Véla, E., Gharzouli, R., Djellouli, Y., Alatou, D., Gachet, S.: *Caractérisation phytosociologique de la végétation du parc national de Gouraya (Béjaïa, Algérie)*. Revue d'Ecologie, Terre et Vie, 66(3), 2011, p.267-289;
19. Rebbas, K., Bounar, R.: *Approche phytosociologique d'une zone steppique: El Haourane (Hammam Dalaa, M'Sila-Algérie)*; Afrique Science: Revue Internationale des Sciences et Technologie, 8(3), 2012, p. 102-106;
20. Rebbas, K.: *Développement durable au sein des aires protégées algériennes, cas du Parc National de Gouraya et des sites d'intérêt biologique et écologique de la région de Béjaïa*. Thèse de doctorat. Université Ferhat Abbas, Sétif. 2014.
21. Laribi, M.: *Les Mares temporaires du nord-est de la grande kabylie : Divesité phytocoenotique, floristique et conservation*. Thèse de doctorat. Université Mouloud Mammeri, Tizi-Ouzou. 2016;
22. Taibaoui, B., Douaoui, A., Bouxin, G.: *Diversité floristique de la steppe sud Algéroise: cas de la region de Djelfa (Algérie)*. Lejeunia, Revue de Botanique, 203, 2020, p. 1-41;
23. Véla, E., Benhouhou, S.: *Évaluation d'un nouveau point chaud de biodiversité végétale dans le Bassin méditerranéen (Afrique du Nord)*. Comptes rendus biologies, 330(8), 2007, p. 589-605;
24. Dahmani, M.: *Le chêne vert en Algérie. Syntaxonomie, phytosociologie et dynamique des peuplements*. Thèse de doctorat. Université Science. Technologie Houari Boumediene, Alger. 1997;
25. Gharzouli R.: *Flore et végétation de la Kabylie des Babors. Etude floristique et phytosociologique des groupements forestiers te post forestiers des djebels Takoucht, Adrar Ou Mellal, Tababort et Babor*. Thèse de Doct. Univ. Sétif, Algérie. 2007.
26. Braun-Blanquet, J, & Bolòs i Capdevila, O. D.: *Les groupements végétaux du bassin moyen de l'Ebre et leur dynamisme*. 1958;
27. Kaabeche, M.: *Les groupements vegetaux de la region de Bou Saada (Algérie); essai de synthèse sur la végétation steppique du Maghreb*. Thèse de doctorat. Université de Paris-Sud. 1990;
28. Djebaili, S.: *Recherches phytoécologiques et phytosociologiques sur la végétation des Hautes Plaines steppiques et de l'Atlas Saharien algériens*. Thèse de doctorat. Université Science Technologie, Languedoc, Montpellier. 1978;
29. Aidoud-Lounis, F.: *Contribution à la connaissance des groupements à sparte (Lygeum spartum L.) des hauts plateaux sud-oranais: étude phytoécologique et syntaxonomique*. Thèse de doctorat. Université Science, Technologie Houari Boumediene, Alger. 1984;
30. Bensettiti, F.: *Contribution à l'étude phytosociologique des ripisylves du Nord de l'Algérie: essai de synthèse à l'échelle de la Méditerranée occidentale*. Thèse de doctorat. Paris 11. 1995.

Annex 1

*Psychine stylosa* Desf.*Anarrhinum fruticosum* Desf.*Datura innoxia* Mill.*Hyoscyamus albus* L.*Thymus munbyanus* Boiss. & Reut.*Thymus algeriensis* Boiss. & Reut.*Thymus pallescens* de Noë*Androrchis olbiensis* (Reut. ex Gren.) D. Tyteca & E. Klein*Rumex vesicarius* L.*Ophrys omeqifer* subsp. *hayekii* (H. Fleischm. ex Soó) Kreutz*Eryngium campestre* L.*Astragalus armatus* Willd.

*Ebenus pinnata* L.*Hertia cheirifolia* (L.) Kuntze*Centaurea hyalolepis* Boiss.*Rosmarinus eriocalyx* Jord. & Fourr.*Erinacea anthyllis* Link.*Bupleurum spinosum* L.*Spartium junceum* L.*Carthamus pinnatus* Desf.*Centaurea acaulis* L.*Centaurea involucreta* (Desf.) Talavera

*Illustration of rare and endemic plants
in Dréat (Photos: K. Rebbas)*

Annex 2

Phytosociological table (1) of the *Quercus ilex* & *Juniperus phoenicea* community

Relevé number	S003	S007	S012	C001	C002	k001	k002	k003	k004	K009	
Altitude	1590	1600	1590	770	760	1225	1210	1210	1200	1195	
Aspect	S	S	S	E	E	N	N	N	E	E	
Slope	P3	P3	P3	P3	P3	P2	P2	P2	P1	P1	
Cover (%)	60	50	60	50	40	80	60	60	60	60	
Area (m ²)	100	100	100	100	100	100	100	100	100	100	
Characteristic species											
<i>Quercus ilex</i>	r	1	r		r	1	2	4	+	1	9
<i>Juniperus phoenicea</i>	1	1	1	r		3	1	.	+	3	8
Differential species and variations											
<i>Scabiosa stellata</i>	2	1	2								3
<i>Linum strictum</i>	+	+	+								3
<i>Helianthemum pilosum</i>	r	r	+								3
<i>Aegilops triuncialis</i>	+	+	r								3
<i>Thymus algeriensis</i>				1	1						2
<i>Pituranthos scoparius</i>				1	2						2
<i>Asparagus albus</i>				+	1						2
<i>Iris sisyrinchium</i>				+	+						2
<i>Astragalus peregrinus</i>						+	+	+	+	+	5
<i>Ornithogalum umbellatum</i>						r	r	r	r	r	5
<i>Alyssum granatense</i>						1	+	+	+	1	5
<i>Asphodelus microcarpus</i>						1	+	+	1	1	5
EC of the upper units (<i>Pistacio-Rhamnetalia alaterni</i> and <i>Quercetea ilicis</i>)											
<i>Phillyrea angustifolia</i>	3	3	2			2	3	1	2	2	8
<i>Pistacia lentiscus</i>	3	3	2			3	2	1	1	3	8
<i>Jasminum fruticans</i>	+	+	r			.	+	r	+	.	6
<i>Ampelodesma mauritanicum</i>				+	+	+	+	+	+	+	6
<i>Cistus albidus</i>						+	+	+	1	+	5
<i>Iris inguicularis</i>	+	+	r								3
Characteristics of <i>Rosmarinetea officinalis</i>											
<i>Pallenis spinosa</i>	+	+	+	r	.	+	.	r	+	+	8
<i>Rosmarinus tournefortii</i>	3	3	2			+	3	1	2	+	8
<i>Globularia alypum</i>	1	1	+			2	4	2	3	2	8
<i>Teucrium polium</i>				+	r	r	.	r	r	r	6
<i>Teucrium pseudochamaepitys</i>				+	+	+	+	+	+	r	6
Characteristics of <i>Tuberarietea guttatae</i>											
<i>Atractylis cancellata</i>	+	+	+			+	+	+	+	+	8
<i>Anthyllis tetraphylla</i>				+	r	+	.	r	r	+	6
<i>Echinaria capitata</i>						+	+	+	+	+	5
<i>Sedum album</i>						1	+	2	+	1	5
<i>Helianthemum ledifolium</i>						+	1	1	+	r	5

<i>Helianthemum salicifolium</i>						+	+	+	+	r	5
<i>Euphorbia falcata</i>				r	r		r	r			4
<i>Elymus caput-medusae</i>				r	r			+			3
<i>Xeranthemum inapertum</i>						r			r	r	3
<i>Brachypodium distachyum</i>	+	+	.								2
<i>Lobularia maritima</i>							+	r			2
<i>Reichardia tingitana</i>								r			1
Characteristics of Lygeo-Stipetea											
<i>Stipa tenacissima</i>	3	2	3	2	2	1	1	1	2	+	10
<i>Allium cupani</i>	2	2	1	+	+		+		.		6
<i>Artemisia herba-alba</i>				1	2		+		+		4
<i>Paronychia argentea</i>	+	+	r								3
<i>Scorzonera undulata</i>						+	.		+	+	3
<i>Astragalus incanus</i>				+	r						2
<i>Dactylis glomerata</i>				+	r						2
<i>Poa bulbosa</i>								r			1
<i>Matthiola fruticulosa</i>								r			1
Characteristics of Stellarietea mediae											
<i>Coronilla scorpioides</i>	+	+	+	+	r	+	+	+	+	+	10
<i>Valerianella coronata</i>	+	+	r	+		1	+	+	+	1	9
<i>Kentranthus calcitrapa</i>	+	+	+	r	r						5
<i>Bromus madritensis</i>	+	+	.			+			+	+	5
<i>Fumaria parviflora</i>				r	r	r			r	r	5
<i>Vella annua</i>				r	r		1	.	1		4
<i>Anagallis arvensis</i>				r	r		+	+			4
<i>Aegilops triuncialis</i>	+	+	r								3
<i>Leontodon hispidulus</i>									+		1
Other species											
<i>Filago spathulata</i>	+	+	+			+	+	+	+	+	8
<i>Sinapis arvensis</i>				1	1	1		2	+	1	6
<i>Phalaris minor</i>	+	+	+			.	+	+		.	5
<i>Iberis odorata</i>				r	r	r			r	r	5
<i>Eruca vesicaria</i>				+	+	+			+	+	5
<i>Silene gallica</i>						+	+	+	+	r	5
<i>Minuartia campestris</i>						+	+	+	+	+	5
<i>Androsace maxima</i>						+	+	r	+	+	5
<i>Bellis annua</i>				r	r		+	+	.	.	4
<i>Erinacea Anthyllis</i>						+	.	1	.	+	3
<i>Linaria reflexa</i>						r	.	.	r	r	3
<i>Galium setaceum</i>				+	+						2
<i>Medicago arabica</i>				r	r						2
<i>Reseda alba</i>				+	+						2
<i>Allium paniculatum</i>				+	r						2
<i>Mantisalca salmantica</i>				+	r						2

<i>Galium Valantia</i>				+	+						2
<i>Erodium hirtum</i>							r	r			2
<i>Plantago psyllium</i>							+	+			2
<i>Silene secundiflora</i>							r	r			2
<i>Valerianella eriocarpa</i>							+	1			2
<i>Crepis fetida</i>							+	+			2
<i>Galium pusillum</i>							+	+			2
<i>Linum strictum</i>									+		1
<i>Plantago lanceolata</i>									r		1
<i>Silene laeta</i>							.	r			1
<i>Lotus corniculatus</i>							+				1
<i>Plantago ovate</i>								+			1

Phytosociological table (2) of the association *Calicotomo spinosae-Quercetum rotundifoliae* Dahmani 1997

Relevé number	S001	S002	S004	S005	
Altitude	1600	1590	1100	1000	
Aspect	N	N	N	N	
Slope	P3	P3	P1	P3	
Cover (%)	70	70	80	60	
Area (m ²)	100	100	100	100	
Characteristic species of <i>Calicotomo spinosae-Quercetum rotundifoliae</i> Dahmani 1997, <i>Genista tricuspidatae-Calicotomion spinosae</i>					
<i>Quercus ilex</i>	4	4	4	4	4
<i>Genista tricuspidata</i>	2	2	2	2	4
<i>Calycotome spinosa</i>	1	1	1	1	4
<i>Juniperus oxycedrus</i>	r	+	r	r	4
<i>Ampelodesma mauritanicum</i>	.	+	+	.	2
Characteristics of <i>Pistacio-Rhamnetalia alaterni</i>					
<i>Pistacia lentiscus</i>	3	3	3	3	4
<i>Jasminum fruticans</i>	r	.	.	r	2
Characteristics of <i>Quercetea ilicis</i>					
<i>Phillyrea angustifolia</i>	3	3	3	3	4
<i>cistus albidus</i>	3	3	3	3	4
<i>Juniperus phoenicea</i>	1	1	2	1	4
<i>Irisinguicularis</i>	.	.	+	.	1
Characteristics of <i>Cisto-Rosmarinetea</i>					
<i>Rosmarinus tournefortii</i>	2	2	2	2	4
<i>Cistus monspeliensis</i>	1	1	1	1	4
<i>Plantago psyllium</i>	r	r	r	r	4

<i>Teucrium pseudochamaepitys</i>	.	r	.	.	1
Characteristics of <i>Tuberarietea guttatae</i>					
<i>Brachypodium distachyum</i>	3	3	3	3	4
<i>Echinaria capitata</i>	r	r	r	r	4
<i>Linum strictum</i>	+	+	+	+	4
<i>Sedum album</i>	+	+	+	+	4
<i>Elymus caput-medusae</i>	+	+	+	+	4
<i>Euphorbia falcata</i>	r	r	r	r	4
<i>Filago spathulata</i>	+	+	+	+	4
<i>Atractylis cancellata</i>	.	.	.	+	1
<i>Scabiosa stellata</i>	.	.	.	1	1
Characteristics of <i>Lygeo-Stipetea</i>					
<i>Alium cupani</i>	r	r	r	r	4
<i>Poa bulbosa</i>	r	r	r	r	4
Characteristics of <i>Stellarietea mediae</i>					
<i>Aegilops triuncialis</i>	r	r	r	r	4
<i>Bromus madritensis</i>	1	1	1	1	4
<i>Kentranthus calcitrapa</i>	+	+	+	+	4
<i>Senecio vulgaris</i>	r	r	r	r	4
<i>Sinapis arvensis</i>	1	1	1	1	4
<i>Valerianella coronata</i>	+	+	+	+	4
<i>Coronilla scorpioides</i>	.	.	+	.	1
<i>Muscari comosum</i>	.	.	r	.	1
<i>Torilis arvensis</i>	.	.	.	1	1
Other species					
<i>Anagallis arvensis</i>	1	1	1	1	4
<i>Astragalus peregrinus</i>	r	r	r	r	4
<i>Helianthemum pilosum</i>	+	+	+	+	4
<i>Medicago arabica</i>	r	r	r	r	4
<i>Medicago minima</i>	+	+	+	+	4
<i>Valerianella eriocarpa</i>	+	+	+	+	4
<i>Alyssum granatense</i>	+	+	+	+	4
<i>Ononis alba</i>	+	+	+	+	4
<i>Silene gallica</i>	+	+	+	+	4
<i>Ophrys speculum</i>	r	r	r	r	4
<i>Genista ulicina</i>		+	r		2
<i>Minuartia tenuifolia</i>	+	.	.	.	1
<i>Ophrys mirabilis</i>	.	.	r	.	1

Phytosociological table (3) of the *Juniperus phoenicea* & *Rosmarinus tournefortii* community

Relevé number	H05	H06	H007	H008	H010	H011	H012	H013	H014	H015	H016	H017	H034	H037	S008	S009	S010	S011	
Altitude	900m	950m	1000m	1050m	1000m	1050m	1100m	1120m	1120m	1130m	1100m	1100m	1000m	1000m	1590	980	990	1000	
Aspect	SW	SW	SW	S	N	N	N	N	N	N	N	E	N	S	S	W	W	W	
Slope	P2	P2	P3	P3	P2	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P1	P1	P2	
Cover (%)	70%	50%	50%	50%	50%	50%	50%	60%	50%	50%	50%	50%	60%	50%	50	80	70	60	
Area (m ²)	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	100m ²	
Characteristic species																			
<i>Juniperus phoenicea</i>	1	3	2	2	2	2	2	3	.	2	2	2	2	2	4	2	3	4	17
<i>Rosmarinus tournefortii</i>	r	r	+	r	1	+	.	+	+	+	r	+	r	.	2	1	+	+	16
EC of the upper units (<i>Pistacio-Rhamnetalia alaterni</i> and <i>Quercetalia ilicis</i>)																			
<i>Pistacia lentiscus</i>	1	1	+	+	1	1	1	1	1	1	1	1	1	+		+			15
<i>Phillyrea angustifolia</i>	+	r	+	.	.	+	+	+	+	r	+	r	.	r				+	12
<i>Olea europaea</i>	.	r	+	.	.	+	.	.	+	r	+	.	.	r					7
<i>Quercus ilex</i>	.					r	.	r	r	.		r	r	r					6
<i>Ampelodesma mauritanicum</i>	+							+	.	.		+	.	.					3
<i>Asparagus acutifolius</i>	.	+	+	.	+			.	.	.									3
<i>Juniperus oxycedrus</i>	.	.	.	r	.			.	+	r									3
<i>Pinus halepensis</i>	4	1	.	.	.			.	.	.									2
<i>Prasium majus</i>	.	.	.	r	.			.	.	.									1
<i>Rhamnus lycioides</i>	.	.	.	.	.	+	.	.	.	.									1
Characteristics of Cisto- <i>Rosmarinetea officinalis</i>																			
<i>Globularia alypum</i>	2	+	.	1	+	+	1	+	+	+	1	1	.	r			1	+	14
<i>Teucrium pseudochamaepitys</i>	.	.	.	.	.	+	.	r	.	.	.	+	.	.	1	2	+		6
<i>Helianthemum virgatum</i>	.	.	r	r	.										+	r	.	r	5
<i>Phagnalon saxatile</i>	.	.	.	.	+										+	+	.	+	4
<i>Cistus monspeliensis</i>															.	+	1	1	3
<i>Teucrium polium</i>	.	.	+	.	.	.	.	r	.	.	.	.	.	.		+			3
<i>Jasminum fruticans</i>																	1	+	2
<i>Sedum album</i>															.	+	+	.	2
Characteristics of <i>Tuberarietea guttatae</i>																			
<i>Echinaria capitata</i>	2	.	.	.	.	.	.	r	.	.	.	.	.	.	+	r	.	r	5
<i>Atractylis cancellata</i>	.	.	r	.	r										r	1	.	+	5
<i>Micropus bombycinus</i>	.	.	r	.	.										1	.	.	+	3
<i>Scabiosa stellata</i>															.	+	+	.	2
<i>Rumex bucephalophorus</i>							r								+	.	.	.	2

<i>Lotus edulis</i>	.	r	.	.	.	.	r	.	.	.	.	.	.	.	.	.					2
<i>Linaria simplex</i>	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	r	+			2
<i>Euphorbia falcata</i>																					
<i>Convolvulus althaeoides</i>	.	.	.	.	r	.	.	.	r	.	.	.	.	.	.	.					2
<i>Calendula arvensis</i>																	+	1	.	.	2
<i>Sonchus oleraceus</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.					
<i>Brachypodium pinnatum</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Brachypodium distachyum</i>																	.	.	.	+	1
<i>Anthyllis tetraphylla</i>	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.					
Characteristics of <i>Stellarietea mediae</i>																					
<i>Bromus madritensis</i>	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	+	4
<i>Valerianella coronata</i>																	+	+	.	r	3
<i>Senecio vulgaris</i>	.	r	.	r	.	.	.	.	.	.	.	.	r	.	.	.	+	r			3
<i>Coronilla scorpioides</i>	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.						
<i>Bromus rubens</i>	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	.	+				2
<i>Muscari comosum</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.						
<i>Avena sterilis</i>																	r	r	.	.	2
Characteristics of <i>Lygeo-Stipetea</i>																					
<i>Stipa tenacissima</i>	+	1	1	2	.	1	+	1	2	1	1	1	1	+	3	2	2	.		16	
<i>Sedum sediforme</i>	.	r	.	.	r	.	.	r	.	.	r	r	.	.	.						
<i>Plantago albicans</i>	.	.	.	.	.	.	r	.	.	.	.	.	r	.	.					2	
<i>Iris sisyrynchium</i>	.	+	.	.	+	.	.	.	.	.	.	.	r	.	.						
<i>Salvia verbenaca</i>	.	.	.	.	r	.	.	r	.	.	.	.	.	.	.					3	
<i>Scorzonera undulata</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.					2	
<i>Artemisia herba-alba</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.					1	
<i>Calendula aegyptiaca</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.					1	
<i>Paronychia argentea</i>	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.					1	
Other species																					
<i>Gagea reticulata</i>	.	.	r	r	.	r	r	.	.	r	r	r	.	.	.					7	
<i>Sedum nicaense</i>	.	r	.	.	r	.	.	r	.	.	r	r	r	.	.					6	
<i>Bellis annua</i>	.	+	1	+	.	.	.	.	.	+	+	.	.	.	.					5	
<i>Tulipa sylvestris</i>	.	.	r	.	.	.	.	.	r	.	.	.	r	r	.					4	
<i>Matthiola fruticulosa</i>	r	.	.	.	r	.	.	r	r	.	.	.	.	.	.					4	
<i>Retama retam</i>	.	r	+	r	r	.	.	.	.	.	.	.	.	.	.					4	
<i>Cistus salvifolius</i>	.	+	.	.	.	.	r	r	.	.	.	r	.	.	.					4	
<i>Brassica amplexicaulis</i>	.	+	.	.	.	.	r	r	.	.	.	r	.	.	.					4	
<i>Muscari neglectum</i>	.	.	.	.	.	.	.	.	.	r	1	r	.	.	.					3	
<i>Adonis annua</i>	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.					2	
<i>Catananche caerulea</i>	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.					2	
<i>Fumaria parviflora</i>	.	.	.	.	.	.	.	r	.	.	.	r	.	.	.					2	

<i>Carlina lanata</i>	.	.	.	.	.	.	.	r	.	.	.	r	.	.					2
<i>Spartium junceum</i>	.	.	.	.	.	.	.	r	.	.	.	r	.	.					2
<i>Polypogon maritimus</i>	.	.	.	.	.	.	.	r	.	.	.	+	.	.					2
<i>Silene rubella</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	r					2
<i>Chrysanthemum fuscum</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1				2
<i>Plantago Psyllium</i>															r	+	.	.	2
<i>Chrysanthemum multicaule</i>															.	2	.	1	2
<i>Sedum acre</i>															r	r	.	.	2
<i>Iberis odorata</i>															r	.	.	r	2
<i>Alyssum granatense</i>	r	.	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Lobularia maritima</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Bellis sylvestris</i>	.	.	.	.	.	.	r	.	.	.	.	.	.	.					1
<i>Gagea foliosa</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.					1
<i>Centaurea acaulis</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1
<i>Erodium cicutarium</i>	.	.	.	.	.	.	.	.	.	.	.	r	.	.				r	1
<i>Erodium hirtum</i>	.	.	.	.	.	.	.	r	.	.	.	.	.	.					1
<i>Eruca vesicaria</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.					1
<i>Medicago hispida</i>	.	.	.	.	.	.	.	.	r	.	.	.	.	.					1
<i>Sanguisorba alveolosa</i>	.	.	.	.	.	.	r	.	.	.	.	.	.	.					1
<i>Helianthemum ledifolium</i>	.	.	.	.	.	r	.	.	.	.	.	.	.	.					1
<i>Linaria reflexa</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Aceras anthropophorum</i>	.	.	.	.	.	.	r	.	.	.	.	.	.	.					1
<i>Ambrosinia bassii</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1
<i>Asparagus acutifolius</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.					1
<i>Asparagus officinalis</i>	r	.	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Atractylis humilis</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Ceterach officinarum</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1
<i>Coleostephus fragrans</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1
<i>Coleostephus myconis</i>	.	.	r	.	.	.	.	.	.	.	.	.	.	.					1
<i>Physoplexis comosa</i>	.	.	.	.	.	.	r	.	.	.	.	.	.	.					1
<i>Kobresia simpliciuscula</i>	.	.	r	.	.	.	.	.	.	.	.	.	.	.					1
<i>Crucianella angustifolia</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.					1
<i>Cynoglossum cheirifolium</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1
<i>Draba muralis</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.					1
<i>Echinophora spinosa</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1
<i>Ephedra major</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.					1
<i>Hyoseris radiata</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.					1

<i>Hypochoeris radicata</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Ilysanthes gratioloides</i>	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1
<i>Lamium garganicum</i>	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Lithospermum apulum</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Forget-me-not</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Ophrys fusca</i>	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1
<i>Ophrys tenthredinifera</i>	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1
<i>Ranunculus macrophyllus</i>	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	1
<i>Roemeria hybrida</i>	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1
<i>Sideritis montana</i>	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	1
<i>Silene tridentata</i>	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	1
<i>Valerianella olitoria</i>	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1
<i>Ebenus pinnata</i>	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Alyssum scutigerum</i>	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	1
<i>Carduus getulus</i>	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	1
<i>Genista demmatensis</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Psychine stylosa</i>	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Silene laeta</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Anagallis monelli</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Zizyphus lotus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Maresia nana</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Helianthemum salicifolium</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Hedysarum spiosisum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Scorpiurus muricatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

Phytosociological table (4) of the *Juniperus phoenicea* & *Stipa tenacissima* community

Relevé number	H004	H026	H025	H035	H036	H038	S006	H003	H027	H028	H030	H029	H018	H019	H020	H023	H001	H002	
Altitude	900	900	900	1100	1050	1000	900	900	910	930	900	900	900	900	900	900	850	840	
Aspect	S	S	W	N	S	N	W	S	S	S	W	W	SW	N	S	S	W	W	
Slope	P3	P2	P1	P3	P3	P3	P2	P1	P2	P2	P3	P3	P2	P1	P1	P1	P1	P1	
Cover (%)	50	40	50	50	50	50	60	50	50	50	50	40	60	50	50	50	50	40	
Area (m²)	100	800x6	100	100	100	100	100	100	100	100	100	100	100	100	100	100	50	50	
Characteristic species																			
<i>Stipa tenacissima</i>	2	+	r	+	1	+	1	1	2	2	+	2	1	2	.	r	4	4	17
<i>Juniperus phoenicea</i>	1	2	1	2	+	2	2	2	+	+	2	+	r	.	.	1			14
Differential species and variations																			
<i>Pistacia lentiscus</i>	1	1	1	1	.	.	3	1	.	r	r	.	.	.	.	r	1	1	11
<i>Bellis annua</i>	.	r	r	.	.	.	.	1	.	+	.	.	.	.	+				5
<i>Olea europaea</i>	.	.	.	+	.	r	.												2
<i>Globularia alypum</i>									r	r	r	r	.	1	.	r			6
<i>Teucrium pseudochamaepitys</i>									r	r	r	r	.	.	.	+			5

<i>Pinus halepensis</i>														3	r	3	3			4
<i>Echinaria capitata</i>														2	+	2	.			3
<i>Asparagus albus</i>									+	.	.	r		+	.	.	.	1	1	5
<i>Launaea acanthoclada</i>																		1	1	2
<i>Scabiosa stellata</i>	.	.	.	.	r	.	.	.										1	1	3
EC of the upper units (<i>Stipetalia tenacissimae</i> and <i>Lygeo-Stipetea</i>)																				
<i>Artemisia herba-alba</i>	.	.	1	.	2	1	.		1	1	+	1	.	2	2	1	3	3	12	
<i>Matthiola fruticulosa</i>	.	+	+	.	.	r	.	+	.	.	r	r	+	+	+	.	+	+	11	
<i>Plantago albicans</i>	1	+	+	.	r	.	.	+					1	.	.	.	1	+	8	
<i>Salvia verbenaca</i>	+	.	.	.	r	.	.						r	+	.	.	r	+	6	
<i>Paronychia argentea</i>	.	.	.	.	r	.	.						.	.	r	r	+	r	5	
<i>Helianthemum virgatum</i>								r					.	r	r	.	+	r	5	
<i>Sedum sediforme</i>									r	r	.	r							3	
<i>Sinapis pubescens</i>	.	.	.	.	.	.	1										+	+	3	
<i>Stipa parviflora</i>																	+	+	2	
<i>Astragalus incanus</i>																	+	+	2	
<i>Allium cupani</i>																	+	+	2	
<i>Iris sisyrinchium</i>																	+	+	2	
<i>Poa bulbosa</i>																	r	r	2	
Characteristics of <i>Quercetea ilicis</i>																				
<i>Ampelodesma mauritanicum</i>	.	.	.	.	.	.	.	+					+	.	.	.	.			2
<i>Rhamnus lycioides</i>	.	.	.	.	.	+	.	.					.	.	r	.	.			2
<i>Prasium majus</i>	.	.	r	.	.	.	.	.					+	.	.	.	.			2
<i>Phillyrea angustifolia</i>	.	.	.	.	.	r	.	.					.	.	.	.	.			1
Characteristics of <i>Rosmarinetea officinalis</i>																				
<i>Teucrium polium</i>	r	.	.	r	.	.	.	.		r	r	r	r	.	.	.	r			7
<i>Globularia alypum</i>										r	r	r	r	.	1	.	r			6
<i>Pallenis spinosa</i>	.	.	.	r	.	r	.	.										.		3
<i>Rosmarinus tournefortii</i>	r	.	.	.	.	.	.	.		.	.	r	.	.	.	.	r			3
<i>Phagnalon saxatile</i>	.	r	.	.	.	.	.	.	r											2
<i>Thymus algeriensis</i>																		r	+	2
<i>Cistus monspeliensis</i>	.	.	r	.	.	.	.	.												1
<i>Juniperus oxycedrus</i>									r											1
<i>Leuzea conifera</i>														.	.	.	r			1
<i>Fumana thymifolia</i>														.	.	.	r			1
<i>Thymus ciliatus</i>														.	.	.	+			1
Characteristics of <i>Tuberarietea guttatae</i>																				
<i>Anthyllis tetraphylla</i>	.	.	r	.	.	.	.	.						.	.	.	r	+	+	4
<i>Micropus bombycinus</i>	.	.	.	.	r	r	.	.						.	.	r	.			3
<i>Rumex bucephalophorus</i>	.	.	.	r	r	.	.	.												2
<i>Brachypodium distachyum</i>	.	.	.	.	.	.	.	1						.	.	r	.			2

<i>Elymus caput-medusae</i>																		+	+	2
<i>Filago spathulata</i>	.	.	.	.	.	r		.												1
<i>Lotus edulis</i>								r												1
<i>Linaria simplex</i>													r	.	.	.				1
Characteristics of <i>Stellarietea mediae</i>																				
<i>Reseda alba</i>	.	.	.	r	.	.	.	.	.	r	.	.	r	r	+	r				6
<i>Reseda luteola</i>	.	.	.	.	.	.	+											+	+	3
<i>Bromus rubens</i>								1								r				2
<i>Coronilla scorpioides</i>																		1	1	2
<i>Ceratocephalus falcatus</i>																		r	r	2
<i>Muscari comosum</i>								+					.	.	.	r				2
<i>Senecio vulgaris</i>	r	.	.	.	.	.	.						.	.	r	.				2
<i>Valerianella coronata</i>	.	.	.	.	.	.	+													1
<i>Biscutella didyma</i>	r	.	.	.	.	.	.													1
<i>Lamium amplexicaule</i>	.	.	.	.	r	.	.													1
<i>Torilis arvensis</i>													.	.	r	.				1
Other species																				
<i>Tulipa sylvestris</i>	.	r			.	r		r	.	r	r	r								6
<i>Marrubium vulgare</i>	r	.	.	.	.	.	.	.	.	r	.	.	+	.	.	r				4
<i>Erodium malacoides</i>	.	.	.	.	r	.	.	.	.				.	.	+	r				3
<i>Sedum nicaense</i>	.	r	.	.	.	.	.	.	.				r	.	r	.				3
<i>Adonis annua</i>								r					+	.	.	r				3
<i>Anagallis monelli</i>	.	r	.	.	.	.	.	.	.	r	.	.	.	.	.	r	.			3
<i>Medicago arabica</i>	.	.	.	.	.	.	1											+	+	3
<i>Chrysanthemum multicaule</i>	+	1	.	.	.	.	.	.												2
<i>Lobularia maritima</i>								r					.	.	.	r				2
<i>Bellis sylvestris</i>								1					r	.	.	.				2
<i>Gagea foliosa</i>								r					.	.	r	.				2
<i>Erodium cicutarium</i>													r	r	.	.				2
<i>Thymelaea hirsuta</i>													.	r	r	.				2
<i>Lepidium subulatum</i>													r	r	.	.				2
<i>Marrubium supinum</i>													r	.	.	r				2
<i>Eruca vesicaria</i>																		1	1	2
<i>Silene laeta</i>																		r	r	2
<i>Asteriscus pygmaeus</i>																		r	r	2
<i>Inula montana</i>																		r	r	2
<i>Astragalus peregrinus</i>	.	.	.	.	.	.	+													1
<i>Anagallis arvensis</i>																		1	.	1
<i>Aegilops triuncialis</i>	.	.	.	.	.	.	1													1
<i>Sanguisorba alveolosa</i>	r	.	.	.	.	.	.													1
<i>Sinapis arvensis</i>	.	.	.	.	.	.	1													1
<i>Silene gallica</i>	.	.	.	.	.	.	+													1

<i>Ophrys speculum</i>	.	.	.	.	.	.													1
<i>Capsella bursa-pastoris</i>	.	.	.	.	.	.	1												1
<i>Cistus salvifolius</i>	.	.	.	.	.	r	.												1
<i>Cynoglossum cheirifolium</i>	r	.	.	.	.	.	.												1
<i>Soft geranium</i>	r	.	.	.	.	.	.												1
<i>Gladiolus byzantinus</i>	.	.	.	.	.	.	r												1
<i>Spergula pentandra</i>	.	.	r	.	.	.	.												1
<i>Centaurea musimomum</i>	.	r	.	.	.	.	.												1
<i>Silene rubella</i>	r	.	.	.	.	.	.												1
<i>Retama retam</i>								r											1
<i>Alyssum granatense</i>								r											1
<i>Lamium garganicum</i>								r											1
<i>Polycarpon tetraphyllum</i>								r											1
<i>Helianthemum hirtum</i>								r											1
<i>Gagea granatellii</i>								r											1
<i>Calendula arvensis</i>								+											1
<i>Centaurea acaulis</i>										.	.	r	.						1
<i>Zizyphus lotus</i>										r	.	.	.	.					1
<i>Avena barbata</i>										.	.	.	.	r					1
<i>Crepis vesicaria</i>										r	.	.	.	.					1
<i>Cynoglossum cheirifolium</i>										.	.	r	.	.					1
<i>Euphorbia helioscopia</i>										.	.	r	.	.					1
<i>Evax pygmaea</i>										.	.	r	.	.					1
<i>Koeleria phleoides</i>										.	.	.	.	r					1
<i>Lycium europaeum</i>										.	.	r	.	.					1
<i>Muscari neglectum</i>										.	.	r	.	.					1
<i>Forget-me-not arvensis</i>										r	.	.	.	.					1
<i>Plantago lagopus</i>										.	.	r	.	.					1
<i>Raphanus raphanistrum</i>										+	.	.	.	.					1
<i>Scrophularia canina</i>										.	r	.	.	.					1
<i>Silene italica</i>										r	.	.	.	.					1
<i>Thlaspi perfoliatum</i>										.	.	r	.	.					1
<i>Urospermum picroides</i>										r	.	.	.	.					1
<i>Brassica amplexicaulis</i>										.	.	r	.	.					1
<i>Cytisus arboreus</i>										.	.	r	.	.					1
<i>Marrubium alysson</i>										.	r	.	.	.					1
<i>Picris duriaei</i>										.	.	.	.	r					1
<i>Centaurea involucrata</i>										.	.	.	.	r					1
<i>Papaver rhoeas</i>															.	+			1
<i>Bellevallia mauritanica</i>									.	r	.	.	.	.					1

Phytosociological table (5) of the *Nerium oleander* community

Relevé number	H021	H024	H031	H032	H033	
Altitude	90	90	90	90	90	
Aspect	S	S	S	S	S	
Slope	P1	P2	P1	P2	P1	
Cover (%)	40	40	40	30	30	
Area (m ²)	10x15	10x15	10x15	10x15	10x15	
Characteristics of <i>Nerio - Tamaricetea</i>						
<i>Nerium oleander</i>	1	1	r	1	1	3
<i>Ampelodesma mauritanica</i>	r	r	.	r	r	2
<i>Juncus acutus</i>	r	r	.	r	r	2
Characteristics of <i>Pistacio-Rhamnetalia alaterni</i> and <i>Quercetea ilicis</i>						
<i>Juniperus phoenicea</i>		+	+	+	+	3
<i>Pistacia lentiscus</i>	+	+	+	+	+	3
<i>Phillyrea angustifolia</i>	.	r	r	r	r	2
<i>Olea europea</i>	.	r	.	.	.	1
<i>Prasium majus</i>	.	r	.	.	.	1
Characteristics of <i>Rosmarinetea officinalis</i>						
<i>Rosmarinus tournefortii</i>	r	r	r	r	r	3
<i>Teucrium pseudo-chamaepestis</i>	r	r	.	r	.	2
<i>Globularia alypum</i>	r	r	.	.	r	2
<i>Teucrium polium</i>	r	.	r	.	.	2
<i>Astragalus armatus</i>	r	.	.	.	.	1
Characteristics of <i>Lygeo-Stipetea Riv.-Mart. 1977, em Kaabeche 1990</i>						
<i>Artemisia herba alba</i>	1	1	+	+	r	3
<i>Stipa tenacissima</i>	+	1	r	.	.	3
<i>Salvia verbenaca</i>	r	r	.	r	r	2
<i>Plantago albicans</i>	r	+	.	r	.	2
<i>Sedum sediforme</i>	.	.	r	.	r	1
Other species						
<i>Convolvulus althaeoides</i>	.	r	r	r	.	3
<i>Scorfularia canina</i>	+	r	.	.	.	2
<i>Helianthemum virgatum</i>	r	.	r	.	.	2
<i>Centaurea parviflora</i>	r	.	r	r	.	2
<i>Dactylis glomerata</i>	r	r	.	r	.	2
<i>Hypochaeris pendulum</i>	r	.	r	.	.	2
<i>Matthiola fruticulosa</i>	r	r	.	r	.	2
<i>Clematis cirrhosa</i>	.	r	r	.	.	2
<i>Silene rubella</i>	.	r	r	.	.	2
<i>Thymus hirtus</i>	r	r	.	.	.	2
<i>Galium valentia</i>	.	.	r	.	.	1
<i>Lamium vesicaria</i>	.	.	r	.	.	1
<i>Lamium longiflorum</i>	.	.	r	.	.	1
<i>Erodium triangulare</i>	r	.	.	.	.	1
<i>Micropus bobicinus</i>	r	.	.	.	.	1
<i>Eruca vesicaria</i>	.	.	r	.	r	1
<i>Eryngium tricuspdatum</i>	.	.	r	.	.	1
<i>Thymelaea hirsuta</i>	r	.	.	.	.	1
<i>Bellis sylvestris</i>	.	r	.	.	.	1
<i>Marrubium supinum</i>	.	r	.	.	.	1
<i>Calendula arvensis</i>	.	r	.	r	r	1
<i>Bellevallia mauritanica</i>	.	r	.	.	.	1
<i>Cynoglossum cheirifolium</i>	.	r	.	.	.	1
<i>Hordeum Murinum</i>	.	r	.	.	.	1
<i>Scilla obtusifolia</i>	.	r	.	.	.	1
<i>Moricandia arvensis</i>	r	.	.	.	.	1
<i>Medicago littoralis</i>	r	.	.	.	.	1
<i>Muscari neglectum</i>	.	r	.	r	r	1
<i>Marrubium vulgare</i>	.	.	r	.	r	1
<i>Anagallis monelli</i>	.	.	r	.	.	1
<i>Adonis aestivalis</i>	.	.	.	r	+	2
<i>Sanguisorba minor</i>	r	.	.	.	.	1

Phytosociological table (6) of the *Artemisia herba-alba* & *Eryngium campestre* community

Relevé number	K005	K006	K007	K008	H022	
Altitude	1225	800	820	830	830	
Aspect	N	W	W	W	W	
Cover (%)	60	60	60	50	50	
Area (m ²)	50	50	50	50	100	
Slope	P2	P2	P2	P2	P2	
Characteristic species						
<i>Artemisia herba-alba</i>	3	2	3	2	+	5
<i>Eryngium campestre</i>	.	3	r	+	2	4
EC of the upper units (<i>Launaeion nudicaulis</i> and <i>Stellarietea mediae</i>)						
<i>Phalaris minor</i>	r	r	r	r	.	4
<i>Reseda lutea</i>	+	1	+	r	.	4
<i>Psychine stylosa</i>	.	r	+	+	+	4
<i>Anacyclus tomentosus</i>	r	+	.	.	r	3
<i>Eruca vesicaria</i>	1	+	.	.	r	3
<i>Calendula aegyptiaca</i>	r	r	.	.	.	2
<i>Hypochoeris aetnensis</i>	.	.	+	r	.	2
<i>Aizoon hispanicum</i>	+	1	.	.	.	2
<i>Reseda alba</i>	.	r	.	.	r	2
<i>Plantago lagopus</i>	+	+	.	.	.	2
<i>Sonchus oleraceus</i>	.	.	r	.	.	1
<i>Bromus rubens</i>	+	r	.	.	.	1
Characteristics of <i>Lygeo-Stipetea</i>						
<i>Plantago albicans</i>	r	1	+	.	.	3
<i>Stipa tenacissima</i>	.	.	2	1	.	2
<i>Asteriscus pygmaeus</i>	.	.	.	+	1	1
<i>Moricandia arvensis</i>	1	+	.	.	.	1
Characteristics of <i>Tuberarietea guttatae</i>						
<i>Scabiosa stellata</i>	+	+	+	r	+	5
<i>Atractylis cancellata</i>	+	+	r	+	.	4
<i>Euphorbia falcata</i>	.	.	.	.	r	1
<i>Filago spathulata</i>	+	.	+	.	+	3
<i>Medicago truncatula</i>	.	.	r	r	.	2
<i>Launaea nudicaulis</i>	.	.	r	.	.	1
<i>Convolvulus althaeoides</i>	.	.	r	.	.	1
<i>Scorpiurus muricatus</i>	+	+	.	.	.	2
<i>Reichardia tingitana</i>	.	.	.	.	r	1
Other species						
<i>Helianthemum papillare</i>	1	r	1	.	r	4
<i>Silene rubella</i>	.	.	r	.	r	2
<i>Diploaxis virgata</i>	.	.	r	r	.	2
<i>Sinapis arvensis</i>	.	.	.	.	r	1
<i>Leontodon hispidulus</i>	r	r	.	.	.	2
<i>Erodium malacoides</i>	r	r	.	.	.	2
<i>Silene cerastioides</i>	r	r	.	.	.	2
<i>Phalaris truncata</i>	r	.	.	.	.	1
<i>Pinus halepensis</i>	.	.	.	.	r	1
<i>Bellis annua</i>	.	.	+	.	.	1
<i>Helianthemum hirtum</i>	.	.	.	.	r	1

Phytosociological table (7) of the *Medicago minima* & *Aizoon hispanicum* community

Relevé number	T001	T002	T003	
Altitude	715	720	730	
Aspect	N	N	N	
Cover (%)	70	60	50	
Area (m ²)	40	40	40	
Slope	P1	P1	P1	
Characteristic species				
<i>Medicago minima</i>	2	1	+	3
<i>Aizoon hispanicum</i>	1	2	+	3
<i>Vella annua</i>	+	1	1	3
EC of the upper units (<i>Alliance with Artemisia herba alba</i> and <i>Plantago albicans</i>, <i>Stipetalia tenacissimae</i> and <i>Lygeo-Stipetea</i>)				
<i>Artemisia herba-alba</i>	3	2	1	3
<i>Plantago albicans</i>	r	r	+	3
<i>Scorzonera undulata</i>	.	r	r	2
<i>Euphorbia falcata</i>	r	r	r	3
<i>Paronychia argentea</i>	r	+	r	3
<i>Helianthemum hirtum</i>	.	+	+	2

<i>Lygeum Spartum</i>	r	.	r	2
<i>Stipa tenacissima</i>	+	.	.	1
<i>Allium cupani</i>	+	.	.	1
<i>Atractylis carduus</i>	.	.	r	1
Characteristics of <i>Tuberarietea guttatae</i>				
<i>Eryngium ilicifolium</i>	1	r	r	3
<i>Atractylis cancellata</i>	+	+	.	2
<i>Filago spathulata</i>	2	1	.	2
<i>Calendula arvensis</i>	r	r	.	2
<i>Aegilops ventricosa</i>	r	r	.	2
<i>Trifolium angustifolium</i>	.	.	r	1
<i>Reichardia tingitana</i>	r	.	.	1
<i>Micropus bombycinus</i>	r	.	.	1
<i>Medicago laciniata</i>	r	.	.	1
<i>Hedypnois rhagadioloides</i>	r	.	.	1
<i>Echium pycnanthum</i>	.	.	r	1
Characteristics of <i>Stellarietea mediae</i>				
<i>Eruca vesicaria</i>	+	+	.	2
<i>Reseda lutea</i>	r	r	.	2
<i>Anagallis arvensis</i>	.	r	.	1
<i>Papaver hybridum</i>	.	r	.	1
<i>Eryngium campestre</i>	.	.	2	1
Other species				
<i>Pallenis spinosa</i>	+	+	+	3
<i>Mantisalca salmantica</i>	.	+	r	2
<i>Centaurea involucreta</i>	r	r	.	2
<i>Plantago ciliata</i>	r	r	.	2
<i>Melilotus indica</i>	.	.	+	1
<i>Phalaris truncata</i>	+	.	.	1
<i>Teucrium polium</i>	.	.	+	1
<i>Urospermum picroides</i>	.	+	.	1
<i>Forget-me-not</i>	+	.	.	1
<i>Erucaria uncata</i>	r	.	.	1
<i>Allium flavum</i>	r	.	.	1

Phytosociological table (8) of the sub-association of *Calicotetosum spinosae*

Relevé number	D004	D010	D011	D012	D013	D014	D015	D016	D017	D018	D019	D020	D021	D025	D026	D027	
Altitude	1540	1570	1530	1532	1505	1465	1390	1395	1460	1490	1485	1490	1490	1510	1350	1340	
Aspect	S	S	S	S	W	S	S	S	S	S	S	S	S	W	W	W	
Slope	P3	P2	P3	P3	P2	P2	P1	P1	P2	P1	P1	P2	P2	P2	P2	P2	
Cover (%)	80	60	70	60	40	60	70	70	60	50	40	50	60	50	80	60	
Area (m ²)	15	45	45	45	45	45	45	45	45	45	45	45	45	45	55	55	
Differential of the sub association <i>Calicotetosum spinosae</i>																	
<i>Avena sterilis</i>	1	2	.	+	.	+	r	.	+	2	+	1	+	.	.	.	10
<i>Trifolium pratense</i>	.	.	.	r	.	.	.	+	.	.	.	.	.	.	+	+	4
<i>Inula viscosa</i>	.	.	.	.	.	+	2	3	.	.	.	.	.	.	.	.	3
<i>Plantago major</i>	.	.	1	+	.	.	.	r	.	.	.	.	.	.	.	.	3
<i>Carduus nutans</i>	.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	.	2
Characteristics of the alliance with <i>Calycotome spinosa</i> and <i>Thymus ciliatus</i> Gharzouli 1989																	
<i>Calycotome spinosa</i>	r	.	1	1	1	4	+	+	1	.	1	1	1	2	1	+	14
<i>Ampelodesma mauritanicum</i>	.	r	+	1	+	1	2	r	+	.	2	2	1	.	1	+	13
Characteristics of the :																	
<i>Helintium cinerum</i>	.	.	+	.	+	1	+	.	1	.	.	.	.	+	.	.	4
<i>Rubus ulmifolius</i>	.	.	.	.	.	.	.	.	.	.	.	r	2	1	.	.	3
Characteristics of <i>Rosmarinetea officinalis</i>																	
<i>Thymus dreatensis</i>	.	.	.	+	1	.	+	+	.	+	1	2	.	1	.	.	8
<i>Helianthemum croceum</i>	.	.	+	3	2	+	.	.	.	.	.	.	.	3	.	.	4
<i>Knautia arvensis</i>	.	+	1	.	r	.	.	.	.	.	.	.	.	r	.	.	3
<i>Teucrium polium</i>	.	.	1	+	1	.	.	.	.	.	.	.	.	1	.	.	3
<i>Anthyllis vulneraria</i>	.	+	+	.	+	.	.	.	.	.	.	.	.	+	.	.	3
<i>Pallenis spinosa</i>	.	.	.	.	.	.	.	+	.	.	.	.	.	.	r	.	2
<i>Spartium junceum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	2
<i>Asperula hirsuta</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	1
Characteristics of <i>Erinacetalia</i>																	

<i>Astragalus armatus</i>	.	.	.	.	+	1	.	+	1	.	1	1	.	+			7
<i>Catananche caerulea</i>	.	.	.	.	.	.	.	.	.	.	.	.	r	.			1
<i>Centaurea parviflora</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.			1
<i>Jurinea humilis</i>	.	.	.	+	.	.	.	.	.	.	.	.	.	.			1
Characteristics of Lygeo-Stipetee																	
<i>Paronychia argentea</i>	.	.	.	+	r	.	+	+	.	.	.	.	.	+			5
<i>Scorzonera undulata</i>	.	.	r	.	.	.	r	.	.	+	.	.	2	.			4
<i>Stipa tenacissima</i>	.	.	.	.	+	.	r	.	.	.	.	.	.	+			3
<i>Salvia verbenaca</i>															r	r	2
<i>Koeleria pubescens</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.			1
<i>Stipa parviflora</i>	.	.	r	.	.	.	.	.	.	.	.	.	.	.			1
Characteristics of Tuberarieteeae																	
<i>Aegilops triuncialis</i>	.	4	.	.	+	2	4	4	3	.	2	4	3	+			10
<i>Anacyclus clavatus</i>	+	1	r	r	.	r	3	1	r	+	+	+	.	.			10
<i>Anagallis arvensis</i>	.	+	+	+	+	.	.	.	.	.	.	.	.	+	r	r	7
<i>Filago spathulata</i>	.	.	.	.	.	+	+	+	+	.	+	+	.	.			6
<i>Aegilops ventricosa</i>	.	3	.	2	.	.	.	.	.	+	.	.	1	.	1	+	6
<i>Anthyllis tetraphylla</i>	.	.	+	.	+	+	.	.	+	.	.	.	.	+			5
<i>Eryngium triquatum</i>	.	.	.	.	.	.	+	+	.	.	+	+	+	.			5
<i>Linum strictum</i>	.	.	.	.	.	.	+	+	+	+	.	.	.	.			4
<i>Salvia verbenaca</i>	1	.	.	.	.	.	r	r	.	+	.	.	.	.			4
<i>Brachypodium distachyum</i>	.	.	.	.	.	.	2	3	.	.	.	.	.	.			2
<i>Allium paniculatum</i>	.	.	.	.	.	r	.	.	r	.	.	.	.	.			2
<i>Echinaria capitata</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Rumex bucephalophorus</i>	.	.	.	.	.	.	.	.	.	r	.	.	.	.			1
Characteristics of Stellarieteeae																	
<i>Bromus madritensis</i>	.	+	.	.	.	.	.	.	+	.	.	.	r	.			3
<i>Carduus pycnocephalus</i>	.	.	.	+	.	.	.	.	.	1	.	.	.	.			2
<i>Kentranthus calcitrapa</i>	+	2	.	.	.	.	.	.	.	.	.	.	.	.			2
<i>Leontodon hispanicus</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	2
<i>Plantago serraria</i>															+	+	2
<i>Bromus tectorum</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.			1
<i>Muscari comosum</i>	.	r	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Papaver hybridum</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.			1
<i>Avena sterilis</i>															+	.	1
<i>Erodium cicutarium</i>															r	.	1
<i>Ornithogalum umbellatum</i>															r	.	1
<i>Capsella bursa-pastoris</i>															.	r	1
<i>Linaria reflexa</i>															.	r	1
<i>Sanguisorba verrucosa</i>	.	.	.	.	.	.	.	.	.	.	.	.	r	.			1
Characteristics of Molinio-Arrhenathereteeae																	
<i>Lotus corniculatus</i>	.	.	+	+	1	2	+	+	2	+	.	.	+	r			10
<i>Dactylus glomerata</i>	.	.	.	.	.	.	.	.	.	.	.	.	r	.			1
Other species																	
<i>Galium setaceum</i>	.	.	.	.	+	r	1	1	r	+	.	.	+	+			8
<i>Sinapis arvensis</i>	+	4	.	.	.	.	.	.	.	+	.	.	r		+	+	6
<i>Thapsia garganica</i>	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	r	5
<i>Silene colorata</i>	.	2	.	.	.	.	.	.	.	+	+	+	.	.			4
<i>Echium italicum</i>	1	+	.	.	.	+	.	.	+	.	.	.	.	.			4
<i>Cynara cardunculus</i>	1	.	.	.	.	.	.	.	.	.	1	1	.	.			4
<i>Scorzonera coronopifolia</i>	.	+	.	.	.	.	.	1	1	+	.	.	.	.			4
<i>Sedum acre</i>	.	.	.	.	+	.	+	+			.	.	.	+			4

<i>Psoralea bituminosa</i>	.	.	.	.	.	.	+	+	.	+	.	.	.	.	r	.	4
<i>Asphodelus aestivus</i>	.	.	.	.	.	.	+	.	.	1	.	.	2	.			3
<i>Avena bromoide</i>	.	.	.	+	+	.	.	.	.	.	.	.	.	+			3
<i>Convolvulus althaeoides</i>	.	.	.	.	.	+	.	+	+	.	.	.	.	.			3
<i>Sedum album</i>	.	.	r	.	.	.	+	+	.	.	.	.	.	.			3
<i>Silene muscipula</i>	.	.	.	.	.	.	.	.	.	.	+	+	.	.			3
<i>Centaurea acaulis</i>	.	.	r	+	.	.	.	.	.	.	.	.	.	.	r	r	3
<i>Medicago orbicularis</i>	.	.	.	.	.	.	.	.	.	r	.	.	.	.	1	+	3
<i>Scolymus hispanicus</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	r	3
<i>Silene cucubalus</i>	.	r	.	.	.	.	.	.	.	r	.	.	.	.			2
<i>Atractylis echinata</i>	.	.	.	.	+	.	.	.	.	.	.	.	.	+			2
<i>Echinops spinosus</i>	.	.	.	.	.	.	.	+	.	+	.	.	.	.			2
<i>Plantago psyllium</i>	.	.		2	.	.	+	.	.	.	.	.	.	.			2
<i>Silene secundiflora</i>	.	.	2	1	.	.	.	.	.	.	.	.	.	.			2
<i>Trifolium squarrosum</i>	.	+	.	.	.	.	.	.	.	r	.	.	.	.			2
<i>Nerium oleander</i>															1	1	2
<i>Juncus acutus</i>															+	+	2
<i>Helianthemum helianthemoides</i>															r	r	2
<i>Medicago hispida</i>															1	r	2
<i>Anchusa azaarea</i>	.	.	.	.	.	.	.	.	.	r	.	.	.	.			1
<i>Astragalus incanus</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Borago officinalis</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Vicia sativa</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Matricaria pubescens</i>	.	.	.	.	.	.	.	.	1	.	.	.	.	.			1
<i>Medicago turbinata</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.			1
<i>Minuartia tenuifolia</i>	.	.	.	.	.	.	.	.	.	.	.	.	r				1
<i>Phalaris truncata</i>	.	.	.	.	.	.	.	.	.	.	.	.	2				1
<i>Ranunculus arvensis</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Reseda alba</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.			1
<i>Reseda lutea</i>	.	.	.	r	.	.	.	.	.	.	.	.	.	.			1
<i>Taraxacum obovatum</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	1
<i>Trifolium angustifolium</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.			1
<i>Vicia peregrina</i>	+	.	.		.	.	.	.	.	.	.	.	.	.			1
<i>Centaurea pullata</i>															r	.	1
<i>Galium tunetanum</i>															.	r	1
<i>Hordeum murinum</i>															+	.	1
<i>Galium Mollugo</i>															+	.	1
<i>Cichorium intybus</i>															.	r	1
<i>Lolium perenne</i>																+	1

Phytosociological table (9) of the *Filago spathulata* & *Scorpiurus muricatus* community

Relevé number	D005	D006	D022	D023	O001	O002	
Altitude	1600	1600	1590	1580	990	990	
Aspect	S	S	S	S	E	E	
Slope	P2	P2	P2	P2	P1	P1	
Cover (%)	60	50	60	50	70	60	
Area (m ²)	15	15	15	15	25	25	
Characteristic species							
<i>Filago spathulata</i>	+	1	+	1	r	+	6
<i>Scorpiurus muricatus</i>	2	+	2	+	+	+	6
EC of the upper units (<i>Brachypodietalia distachyae</i>, <i>Tuberarietea guttatae</i>)							
<i>Medicago minima</i>	+	r	1	r	+	r	6
<i>Rumex bucephalophorus</i>	r	r	+		r	r	5
<i>Aegilops triuncialis</i>	+		1	r	r	+	5
<i>Eruca vesicaria</i>	.	.	r	1	+	+	4
<i>Micropus bombycinus</i>	+	r	.	.	+	+	4
<i>Plantago psyllium</i>	.	+	1	+	.	+	4

<i>Crepis vesicaria</i>	r	.	r	.	+	+	4
<i>Anthemis pedunculata</i>	1	r		r		r	4
Characteristics of Rosmarinetea officinalis							
<i>Helintium cinerum</i>	.	3	.	2	.	r	3
<i>Jurinea humilis</i>	r	.	.	.	1	1	3
<i>Helianthemum pilosum</i>	.	1	.	1	.	.	2
<i>Teucrium polium</i>	.	+	.	+	.	.	2
<i>Asperula hirsuta</i>	+	.	+	.	.	.	2
Characteristics of Stellarietea mediae							
<i>Anagallis arvensis</i>	+	+	+	+	+	+	6
<i>Muscari comosum</i>	+	+	+	+	+	+	6
<i>Kentranthus calcitrapa</i>	+	+	+	+	.	.	4
<i>Leontodon hispanicus</i>	+	+	+	+	.	.	4
<i>Valerianella coronata</i>	+	.	+	.	+	+	4
<i>Anacyclus clavatus</i>	+	.	+	.	r	r	4
<i>Coronilla scorpioides</i>	+	.	+	.	+	+	3
<i>Fumaria parviflora</i>	.	.	.	.	1	2	2
<i>Hordeum murinum</i>	.	.	.	.	+	+	2
<i>Sanguisorba verrucosa</i>	.	+	.	+	.	.	2
Other species							
<i>Sinapis arvensis</i>	+	+	+	+	2	1	6
<i>Centaurea pullata</i>	+	+	+	+	.	.	4
<i>Erodium hirtum</i>	+	+	+	+	.	.	4
<i>Vicia sativa</i>	+	+	+	+	.	.	4
<i>Papaver rhoeas</i>	.	r	.	r	r	r	4
<i>Reseda alba</i>	+	.	r	.	+	+	4
<i>Roemeria hybrida</i>	.	.	.	.	+	+	2
<i>Silene colorata</i>	.	.	.	.	1	2	2
<i>Adonis aestivalis</i>	.	.	.	.	+	+	2
<i>Convolvulus tricolor</i>	+	.	r	.	.	.	2
<i>Erodium cicutarium</i>	.	.	.	.	+	1	2
<i>Malva silvestris</i>	.	.	.	.	+	+	2
<i>Medicago arabica</i>	.	.	.	.	+	+	2
<i>Melilotus indica</i>	+	.	+	.	.	.	2
<i>Ranunculus arvensis</i>	.	+	.	+	.	.	2
<i>Silene muscipula</i>	.	.	.	.	r	+	2
<i>Biscutella raphanifolia</i>	.	.	.	.	+	r	2
<i>Echium italicum</i>	+	.	+	.	.	.	2

Phytosociological table (10) of the *Silene colorata* & *Kentranthus calcitrapa* community

Relevé number	D001	D002	D003	D007	D008	D009	
Altitude	1500	1560	1555	1540	1520	1530	
Aspect	S	S	S	S	S	S	
Slope	P2	P2	P2	P2	P2	P3	
Cover (%)	80	70	70	50	60	40	
Area (m ²)	15	15	15	15	15	15	
Characteristic species							
<i>Silene colorata</i>	3	1	1	r	+	+	6
<i>Alyssum granatense</i>	+	2	1	+	+	1	6
<i>Kentranthus calcitrapa</i>	+	2	2	+	+	+	6
EC of the upper units (<i>Alyso serpyllifoliae-Onosmion fastigiatae</i>, <i>Erinacetalia</i> and <i>Rosmarinetea</i>)							
<i>Helianthemum cinerum</i>	+	r	r	+	.	+	5
<i>Anthyllis vulneraria</i>	+	r	.	1	2	+	5
<i>Knautia arvensis</i>	+	.	.	1	+	+	4
<i>Sedum acre</i>	+	.	+	+	.	.	3
<i>Tulipa sylvestris</i>	r	r	.	.	r	.	3
<i>Asperula hirsuta</i>	+	.	.	2	.	2	3
<i>Thymus dreatensis</i>	+	.	.	.	+	+	3
<i>Helianthemum helianthemoides</i>	.	.	.	.	r	+	2
<i>Astragalus armatus</i>	.	.	.	+	+	.	2
<i>Jurinea humilis</i>	.	.	.	+	+	.	2
<i>Pallenis spinosa</i>	.	.	.	.	+	.	2
<i>Ornithogalum umbellatum</i>	+	.	+	.	r	.	2
<i>Catananche caerulea</i>	.	.	.	+	.	.	1
<i>Valeriana tuberosa</i>	+	.	.	.	.	.	1
Characteristics of Quercetea-ilecis							
<i>Calycotome spinosa</i>	.	.	.	1	+	+	3
<i>Ampelodesma mauritanicum</i>	.	.	+	.	.	.	1
<i>Thapsia garganica</i>	r	.	.	.	.	.	1

Characteristics of Tuberarietea-guttatae							
<i>Rumex bucephalophorus</i>	r	+	+	.	r	+	5
<i>Lobularia maritima</i>	+	+	+	.	+	.	4
<i>Medicago minima</i>	+	+	+	.	.	+	4
<i>Filago spathulata</i>	.	.	.	.	.	.	2
<i>Atractylis cancellata</i>	.	.	+	.	.	.	1
<i>Diplotaxis muralis</i>	r	.	.	.	.	.	1
<i>Euphorbia falcata</i>	.	.	.	.	.	r	1
<i>Linum strictum</i>	+	.	.	.	.	.	1
<i>Trifolium stellatum</i>	.	.	.	+	.	.	1
Characteristics of Stellarietea mediae							
<i>Anacyclus clavatus</i>	+	+	+	+	+	3	6
<i>Anagallis arvensis</i>	+	+	+	+	+	+	6
<i>Bromus tectorum</i>	+	1	+	+	4	+	6
<i>Kentranthus calcitrapa</i>	+	2	2	+	+	+	6
<i>Sanguisorba verrucosa</i>	+	+	.	+	+	+	5
<i>Paronychia argentea</i>	+	+	+	.	+	r	5
<i>Aegilops triuncialis</i>	.	.	.	+	4	1	3
<i>Centaurea pullata</i>	.	.	r	+	+	.	3
<i>Senecio vulgaris</i>	+	.	.	.	+	+	3
<i>Bromus madritensis</i>	.	4	3	.	.	.	2
<i>Salvia verbenaca</i>	.	+	.	r	.	.	2
<i>Avena sterilis</i>	2	.	.	.	.	.	1
<i>Carduus pycnocephalus</i>	.	.	.	.	+	.	1
Characteristics of Molinio-Arrhenatheretea							
<i>Lotus corniculatus</i>	+	.	1	r	.	+	4
<i>Dactylis glomerata</i>	+	.	+	.	r	+	4
<i>Plantago lanceolata</i>	.	r	r	.	.	.	2
Other							
<i>Echium italicum</i>	+	+	+	.	+	.	4
<i>Sinapis arvensis</i>	2	+	+	2	.	.	4
<i>Centaurea acaulis</i>	.	.	.	+	+	+	3
<i>Erodium hirtum</i>	+	+	+	.	.	.	3
<i>Papaver rhoeas</i>	.	r	.	r	+	.	3
<i>Borago officinalis</i>	.	1	1	.	.	+	3
<i>Asphodelus aestivus</i>	r	.	+	+	.	.	3
<i>Astragalus peregrinus</i>	.	.	.	+	.	+	2
<i>Astragalus hamosus</i>	.	.	.	1	1	.	2
<i>Carduncellus Pomelianus</i>	.	.	.	+	+	.	2
<i>Vicia sativa</i>	.	+	+	.	.	.	2
<i>Minuartia tenuifolia</i>	r	.	.	.	.	r	2
<i>Silene muscipula</i>	.	.	.	r	.	+	2
<i>Trifolium squarrosum</i>	.	.	.	r	+	.	2
<i>Stipa tenacissima</i>	.	.	.	.	1	+	2
<i>Dasypyrum hordeaceum</i>	.	.	.	.	+	.	1
<i>Erodium triangulare</i>	.	+	.	.	.	.	1
<i>Galium verum</i>	.	.	.	.	.	r	1
<i>Leontodon hispanicus</i>	.	.	.	+	.	.	1
<i>Medicago turbinata</i>	.	r	.	.	.	.	1
<i>Reseda alba</i>	.	.	+	.	.	.	1
<i>Reseda lutea</i>	.	.	.	.	+	.	1
<i>scorzonera coronopifolia</i>	.	.	.	.	.	+	1
<i>Silene nocturna</i>	.	.	.	r	.	.	1
<i>Alium cupani</i>	+	.	.	.	.	.	1