CHARACTERIZATION AND EVALUATION TEST OF THE FOREST LITTER OF THE OAK GROVE (CORK OAK AND ZEEN OAK) OF EL-KALA NATIONAL PARK (PNEK), ALGERIA

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ABSTRACT:

The importance of organic matter in the soil has been highlighted for a long time. Several authors tried to define this fraction: The organic matter is the whole of the carbonaceous and nitrogenous compounds resulting from the degradation of the products of the fauna and the flora, of surface and the basement. It presents a range of very different substances and at very different stages of evolution. The National Park of El-Kala (PNEK) is known by the diversity of ecosystems that are linked to a rich and diverse plant cover dominated by forests of cork oak and Zeen oak, which provides the soil with a significant amount of organic matter in the form of organic debris not decomposed (litter). In order to know and evaluate the litter, two characteristic groups of the vegetation of cover of Ain-Bergougueya were carried out. The morpho-analytical characterization of the litter brings out the dominance of the fraction recognizable on the surface constituted essentially by the leaves and the twigs. Results showed that the chemical characterization of the litter shows that the pH varies little according to the layers; it is more acid on the surface and close to neutrality in contact with the soil, the electrical conductivity is rather low, the water content of the litter varies from one layer to another but is low on the ground. The rapid recycling of organic matter provides the plant cover with mineral salts that are essential for the maintenance and development of rich and diversified vegetation capable of providing many products that can be used by man.

Key words: litter, organic matter, cork oak, zeen oak, PNEK.

Introduction

The Mediterranean forest, a highly entropized environment, constitutes an ecosociosystem (complex system), in which humans and nature interact and are interdependent (Berkes and Folke, 2000).The forest is a complex and rich ecosystem, providing many habitats for numerous animals, plants, fungal, and microbial species and populations, most of which are in interdependent relationships and continuous interactions. It is also a place of production and economic development, but most importantly the forest has become a living space, a place of relaxation and recreation (Kahoul and Ferhani, 2018).

Mediterranean forests are characterized by a great heterogeneity that favors the adaptation of multiple plant formations (Naggar, 1999), they cover about 81million hectares (9.4% of the world's forest area) and are composed of a mosaic of forest species, mainly hardwoods (about 60%) (Mugnossa et al., 2000), Algeria is an integral part of the Mediterranean basin, one of the cradles of

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the oldest civilizations in the world and one of the regions where natural resources (fauna, soil, vegetation) have been thesubject of early solicitations (Louni, 1994). The Algerian forests encompass a significant biological diversity. Several organisms (fungi, plants, insects ...) interact directly or indirectly with living trees and constitute natural and integral elements of ecosystems (Neriere, 2016).Northern Algeria has a real forestry potential that can be developed both for the production of wood resources for the industrial and economic development of the country and for environmental protection and even for social purposes near densely populated centers (Felfli and Fertoul, 2016). The oak forests in Algeria provide essential economic functions; they are the only forests capable of producing hardwoods suitable for fine carpentry, furniture, for railway sleepers and high quality jobs of mechanical resistance (Letreuch-Belerouci, 1995).

The region of El-Kala is located in the extreme east of Algeria; it is characterized by a tangle of several components that has given rise to a particular and specific decor. These components are reflected in the geology, hydrology, climate and soil (De Belair, 1990). Like topography and climate, the geological substratum conditions to a large extent the distribution of the vegetation cover and its growth.In the El Kalala region, the forest flora is divided into three strata: trees, shrubs and herbaceous species. The cork oak is the dominant tree species. The second is the sporadic presence (sometimes in pure micropopulation) of oak zeen (Quercus faginea) and the dune cordon is occupied by the kermes oak (Quercus coccifera). The oak groves are among the richest ecosystems from an entomological point of view, where the trees offer shelter and food to a very diverse entomofauna. However, this entomofauna is linked to trees (leaves, trunks, buds, etc.) they are also found in the woods and other biotopes such as litter.

Many studies have focused on leaf fall in forest ecosystems (Bray and Gorham, 1964). Litter is generally defined as all dead leaves and decaying plant debris that cover the ground (in forests, gardens, hedgerow soils, etc.). Forest litter is mainly composed of leaves and thorns of coniferous trees, branches and fruits representing only 21% in mixed forest and 20 to 40% in coniferous forest. Herbaceous plants contribute less than 5% in temperate forests (Kogel-Knabner, 2002).The annual production of litter varies according to a large number of factors: climate, altitude, latitude, species present, biome, soil fertility, age of the community or stand, seasons, etc.

The decomposition of this litter is the process of physical and chemical degradation of plant tissues. The transformation of this dead organic matter results in the release of energy and the release of water, carbon dioxide and mineral elements into the soil in a form available to plants (Chapin et al., 2002 ; Begon et al., 2006). Decomposition is a fundamental ecosystem process (Swift et al., 1979 ; Cadish and Giller, 1997) as it exerts major control over carbon cycling (Prentice et al., 2001 ; Canadell et al., 2007), nutrient availability and thus plant growth and community structure (Wardle, 2002 ; Bardgett, 2005).

The objective of this work is to evaluate and characterize the physicochemical characteristics of the litter of two oak groups (the cork oak group and the Zeen oak group) of the El-Kala National Park, in the extreme North-East of Algeria.

1- Materials and methods

The national park of EL-Kala (PNEK) is located in the extreme North-East of Algeria and occupies an area of 80.000 Ha. It was created on 23/07/1983 and proclaimed by the U.N.E.S.C.O as a biosphere reserve on 17/12/1990.

It is limited by:

- The Mediterranean Sea, in the North.
- The Medjerda Mountains, in the South.
- The Algerian-Tunisian borders, in the East.
- The plains of El-Taref and Bouteldja as well as the dune belt of Berriane, to the West (Figure 1).

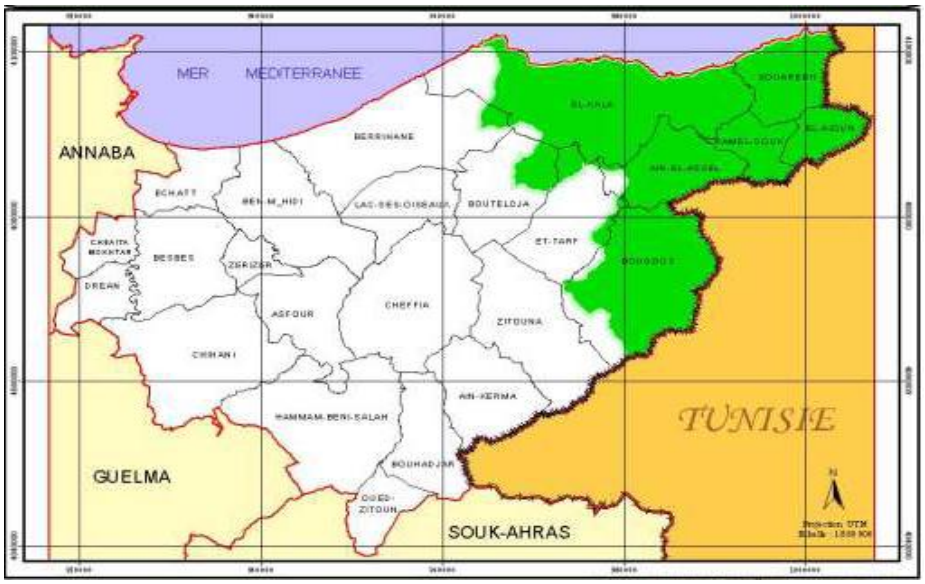

Figure 1 - Geographical location of the study area

This study area in this work belongs to the Mediterranean climate, characterized by an average annual temperature of 18°C, and an average annual precipitation of 634 mm, with an important atmospheric humidity 68%. And according to the climagram of Emberger (1971), this region is under the bioclimatic stage sub-humid mild.

Station of Ain Bergougaya was selected for study. On the road to El-Aioun, in a station formed by a mixed forest of zeen oak and cork oak, located 16 km from the Mediterranean Sea.

Date : 11/03/2019.

Weather : sunny day.

Longitude : 8°36'08.8" E.

Latitude: 36°50'48.6" N.

Altitude: 308m.

Temperature: 21°C.

Geology: Sandstone of Numidia.

Geomorphology: A weak slope.

Climate: The temperature is 18°C.

Vegetation: It is formed essentially of :

Tree stratum: Quercus fagenia

Shrub stratum: Myrtus comminus, Rubus ulmoflus, Sitisus triflorus, Cistus salviflorus, Callicotom espinosa, Milax aspera, Erica arborea. Phelliria angustifolia, Cratigus monogina, Arbbitus unido.

1.1- Litter Collection: For the collection of the litter of two species: Quercus suber, Quercus fagenia, we have two stations:

- The first station is formed of oak zeen (in the wet depression of Ain Bergougueya).

- The second station is formed of cork oak (on the banks (edges) of Ain Bergougueya).

The sampling was done from a plot of 1m2 of surface was determined randomly, delimited and then sampled.The samples thus collected were placed in hermetically sealed bags on which the necessary information corresponding to the sample in question was mentioned. The distinction of layers was made on the basis of the degree of decomposition of the plant material.

1.2- In the laboratory: The sorting of the litter allows the recognition of four fractions (Leaves, stems, fruits and bark and a fraction called miscellaneous gathers the different parts of the litter not recognized), this operation is done by hand.

1.3- Physicochemical analysis of the litter:

- The pH water pH meter (Morel, 1986).

- Electrical conductivity Conductimeter (Duchaufour, 1983).

- Hygroscopic humidity Oven drying (24h at 105°C) (Baize, 2000).

- Organic matter Incineration in muffle furnace (4h at 450°C) (Souchier, 1971 ; Souchier, 1984).

- The percentage of ash contents remaining after muffle furnace incineration at 450°C (Duchaufour, 1970).

1.4- Statistical analysis:

Statistics of The comparison of the three sites of the ouadi of Seybouse (Sidi Salem, the city of Djoinou, and Bouhmra) were realized using (MINITAB 18 Software ANOVA Tukey). Results are expressed as mean ±standard deviation. The significant test was considered at $p<0.05$.

2- Results and discussion

Morphological description of the litter:Zeen oak litter

- Layer1(L1): Large leaves of light brown or brown color mixed with some twigs and well preserved twigs.

- Layer 2 (L2): Brownish-black leaves with little decomposition and organic debris consisting of twig fragments and fruits.

- Layer 3 (L3): Very decomposed organic matter of black color and some fragments of twigs and leaf fragments

The cork oak litter

- Layer 1 (L1): Whole leaves of different sizes of yellow-brown color mixed with whole twigs, these two fractions represent more than 50% of the litter while there are

very few fruits and well preserved fruit carriers.

- Layer 2 (L2): An important decrease of leaves that are brown in color and small in size, not very decomposed, and different organic debris (degraded leaves, fragments of twigs and fruits degraded and others...).
- Layer 3 (L3): Some leaf of brown color with very decomposed debris, and fragments of branches and fruits very degraded and recognizable.

- **Morpho-analytical characterization:**
- Physical separation of litter under zeen oak

2.1- discussion

- Station 1: the physical separation of the litter (zeen oak) from the zone of Ain Bergougaya (table 1)

Table 1-Mean of some morpho-analytical characterization component of the litter in three different layers of zeen oak of Ain-Bergougaya. Results are expressed as mean±SD.

	Leaves	**Stem**	**Ecorse**	**Unknown**	**Fruits**
Layer 1	80.155±0.054^{a}	-	-	19.916±0.094^{b}	-
Layer 2	18.226±0.120^{b}	2.921±0.017^{c}	-	76.886±0.079^{a}	1.781±0.111^{d}
Layer 3	5.665±0.182^{b}	1.688±0.178^{c}	-	92.618±0.255^{a}	0.331±0.011^{d}

Means that do not share the same letter are significantly different at $p<0.05$.

The morphological description of the litter under zeen oak allows us to distinguish three clearly visible layers that are differentiated by the degree of decomposition and alteration of the biological material.

The physical separation carried out on a sample makes it possible to highlight the significant dominance of the leaves (about 80%) in the first layer, the (19%) remaining represent the non-recognizable fraction. We note the absence of stems, bark and fruits, this is perhaps due to their weights, as they fall through the layer of leaves and accumulate in the second layer.

The second layer is dominated significantly by the unrecognizable fraction (about 76%), the leaves represent (18%). The rest is shared between fruits and stems. The presence of an unrecognizable fraction proves a degree of decomposition of leaves from the previous season (zeen leaves are thin and easily biodegradable).

Layer 3 is considered the most degraded part of the litter, it is composed of (about 92%) unrecognizable fragments, and about (5.6%) attacked leaves and a few fragments of stems and remains of fruits that are not very recognizable.

The Zeen oak is a deciduous tree, which completely renews its foliage every year, hence the accumulation of litter dominated by leaves. These leaves are easily biodegradable and provide the soil with an

organic product (through humification) capable of modifying the chemical and physicochemical reactions that take place in the soil.

Physicochemical characterization of the litter under zeen oak:The results of the physicochemical analyses of the litter of the first station are represented in the following figures:

It appears that the pH is more acidic at the surface where the leaves dominate; it becomes more and more neutral going towards the depth. This is perhaps due to a solubility of organic acids at the level of the leaves and a release of mineral elements following an accumulation of mineral elements resulting from the decomposition of the organic matter (OM) (mineralization) (Figure2).

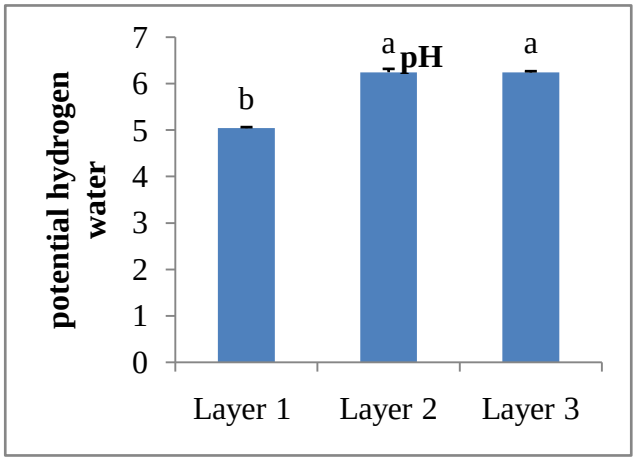

Figure 2- pH evolution in the different layers. Means that do not share the same letter are significantly different at $p<0.05$.

The evaluation of the electrical conductivity (E.C.) parameter shows that the environment is soft, not salty whatever the layer, but we note a relatively high concentration of electrolytes at the level of the surface, and it is perhaps the soluble salts deposited on the leaves (Figure 3).

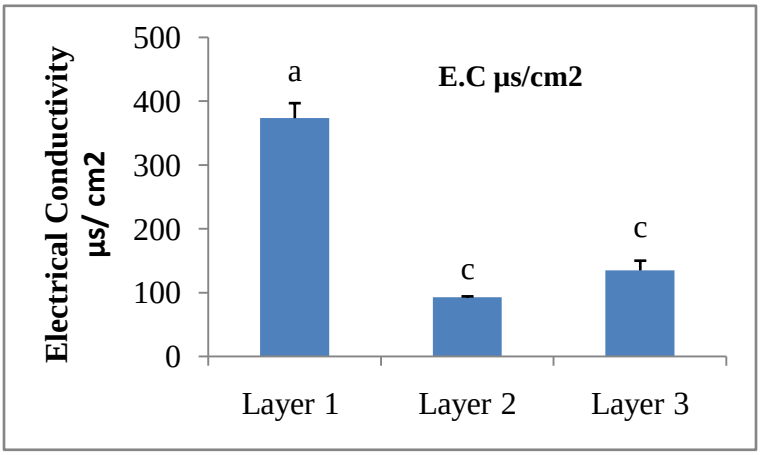

Figure 3 - Evolution of the C.E in the different layers.

Unlike pH, humidity increases with depth but this is a normal evolution because layer 1 records the lowest value, it is exposed to climatic alias. Layer 2 and layer 3 are relatively protected, they retain either from the atmosphere (precipitation, dew, fog) or by the capillary rise of the soil (soil water that rises during evaporation) (Figure 4).

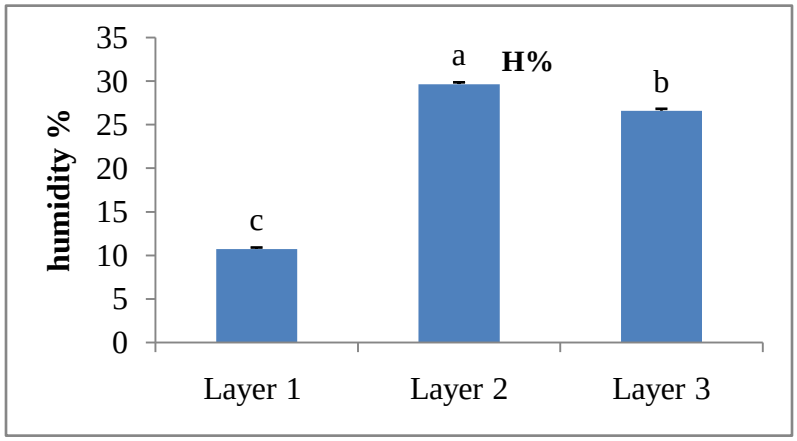

Figure 4 - evaluation of humidity in the three different layers. Means that do not share the same letter are significantly different at $p<0.05$.

Litter is normally composed only of organic matter, but it can retain rock fragments or soluble salts deposited on the surface.Matter organic shows that the first layer is composed of almost (90%) O.M.; the second and third layers are composed of almost (50%) organic matter. These values accurately reflect the reality of the field because layer 1 is composed exclusively of leaves, while in layer 2 and layer 3, there is a mixture between organic compounds from the decomposition of litter and mineral constituents of the soil. This is the beginning of the integration of the O.M with the mineral fraction of the soil (Figure 5).

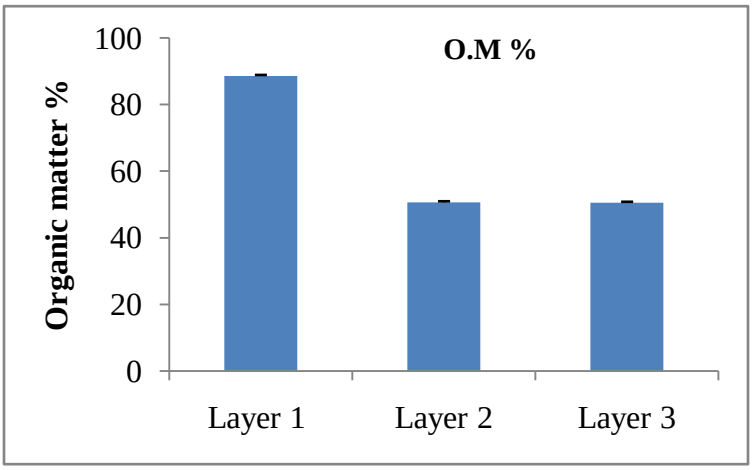

Figure 5 - the evaluation of organic matter in the three different layers. Means that do not share the same letter are significantly different at $p<0.05$.

The evaluation of ash content (TxCend %) confirms the mineral character of the litter in the different layers (layer1, layer2, layer3) (Figure 6).

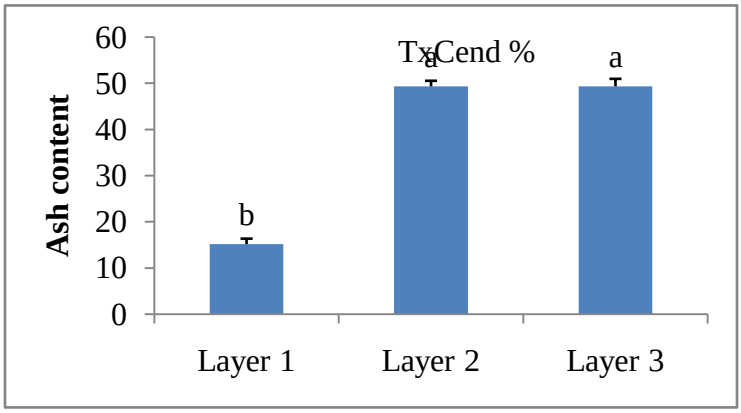

Figure 6 - evaluation of ash content of the three layers. Means that do not share the same letter are significantly different at p<0.05.

Physical separation of the litter under cork oak:Station 2: the physical separation of the litter (cork oak) from the oak grove of Ain-Bergougaya has resulted in the table 1.

Table 2 -Mean of some morpho-analytical characterization component of the litter in three different layers of cork oak of Ain-Bergougaya. Results are expressed as mean±SD.

	Leaves	stem	Ecorse	Unknown	Fruits
Layer 1	12.670±0.254^{b}	61.435±0.248^{a}	8.365±0.136^{e}	9.496±0.157^{d}	11.536±0.119^{c}
Layer 2	27.666±0.186^{b}	23.110±0.053^{c}	-	46.421±0.156^{a}	5.443±0.152^{d}
Layer 3	1.446±0.123^{c}	5.720±0.128^{b}	-	92.320±0.099^{a}	1.453±0.140^{c}

Means that do not share the same letter are significantly different at p<0.05.

The cork oak is known for the persistence of its foliage, the renewal takes place throughout the year, so the fall of leaves is permanent without peak season.The renewal is partial, so the quantities are low, this is translated by small quantities of leaves that will not have time to accumulate, and they are quickly decomposed. This state was recorded in our station.The morphological characterization of the litter under cork oak allows us to distinguish three thin layers that are difficult to separate, but in general, we note that in layer 1, we find the five fractions at variable values dominated by the stems, then the leaves, the fruits and finally the unrecognizable fraction (9.4%).In layer 2, the percentage of leaves increases and the rate of stems decreases significantly. In layer 3, all compounds are degraded, and the unrecognizable fraction dominates and represents about (92%) of the litter.

This morphological dynamic reflects the speed of mineralization or decomposition of organic matter and the influence of environmental conditions; the litter can intervene on the modifications of the physicochemical properties of the soil as indicated in the figures below.

Physicochemical characterization of the litter under cork oak: The results of the physicochemical analyses of the litter from the first station are represented in the following figures:

The monitoring of the pH shows that the environment is more acidic at the surface and becomes less acidic at depth (pH = 6), this is perhaps due to the accumulation of mineral salts at the level of the lower layers (Figure 7).

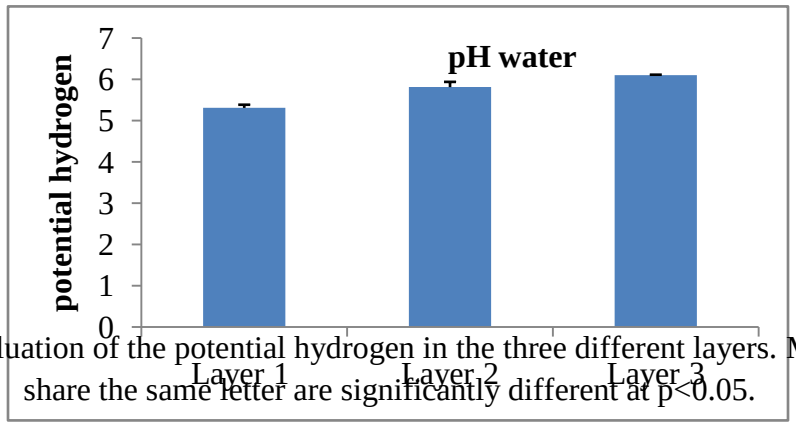

Figure 7 - evaluation of the potential hydrogen in the three different layers. Means that do not share the same letter are significantly different at p<0.05.

Electrical conductivity (E.C.) showed that the environment is less saline whatever the layer (Figure 8); The evaluation of the Hygroscopic humidity (H%) parameter showed that there is a small fluctuation (Figure 10)

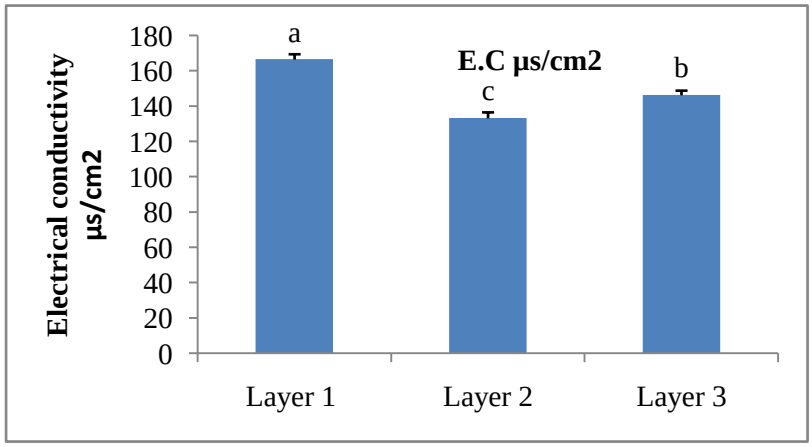

Figure 8 - evaluation of E.C in the three different layers. Means that do not share the same letter are significantly different at p<0.05.

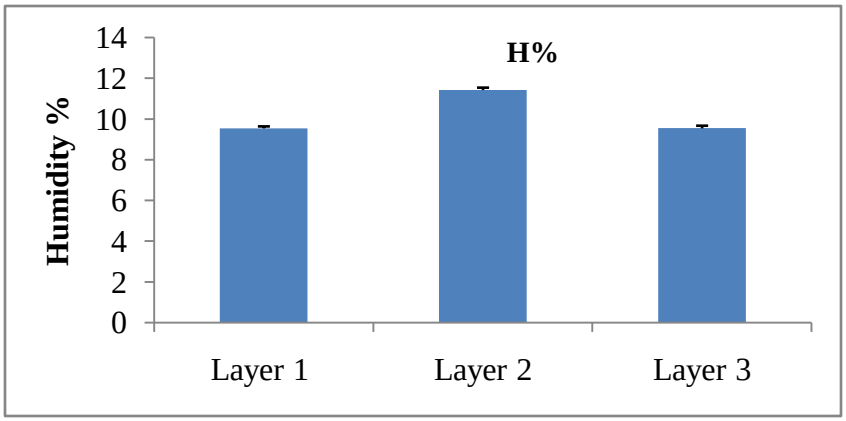

Figure 9 - Evaluation of H in the three different layers.

The cork oak litter is composed mainly of organic matter (O.M) little degraded on the surface (almost 100%), this percentage decreases slightly with depth to reach the (80%) (Figure 10).

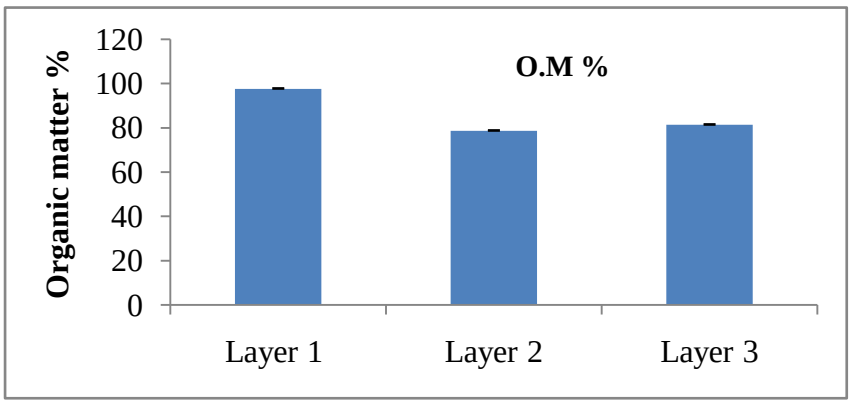

Figure 10 - evaluation of the O.M in the three different layers. Means that do not share the same letter are significantly different at $p<0.05$.

The evaluation of ash content **(TxCend %)** confirmed the mineral character of the litter in the different layers (Layer1, Layer 2, Layer 3) (Figure 11).

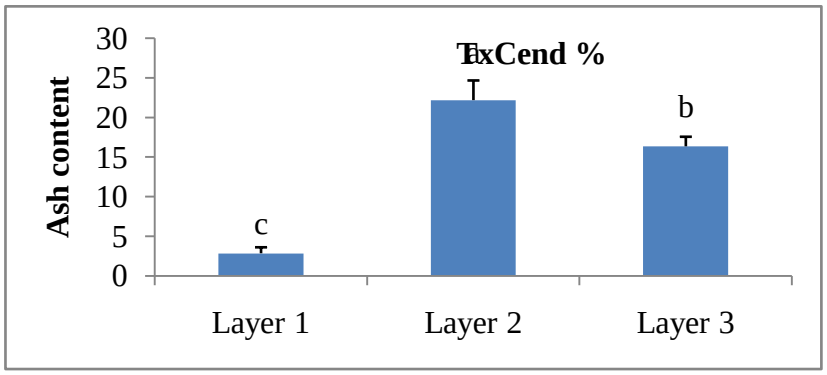

Figure 12 - evaluation of ash content in the three layers. Means that do not share the same letter are significantly different at $p<0.05$.

The importance of organic matter in the soil has been highlighted for a long time; several authors have tried to define this fraction, among these definitions we quote:

The organic matter is the whole of the carbonated and nitrogenous compounds resulting from the degradation of the products of the fauna and the flora, of surface and subsoil. It presents a range of very different substances and at very varied stages of evolution (Duchaufour, 1977).

According to Calvet (2003), soil organic matter (SOM) represents all non-living particulate and molecular organic compounds of animal, plant or microbial origin present in the soil.

Baldock and Skjemstad (1999) define soil organic matter as all organic materials in soils regardless of their origin and state of decomposition.

The zeen oak grouping occupies cool, wet, high elevation areas and is characterized by annual leaf turnover. The annual fall of leaves provides the ground with a large quantity of organic debris in various forms.

On contact with the soil, this organic debris undergoes an evolution, which is a function of the pedoclimatic conditions, the nature of the plant stand and the intensity of biological activity.

Generally, the accumulation of organic debris under the oak tree often defines two layers where the recognizable fractions progressively disappear to integrate into the mineral phase of the soil.

The chemical characterization of the litter in the different layers shows that: the pH varies little according to the layers; it is more acid on the surface and close to neutrality in contact with the soil.

Electrical conductivity is lower earlier. The water content of the litter varies from layer to layer but is low on the ground. The organic matter content of the litter varies from layer to layer but is high on the ground.

When the grouping of cork oak. It is characterized by the permanent renewal of its foliage, i.e. a continuous supply of litter throughout the year.

The litter shows a quantitative and qualitative variability. Thus, the physical separation allows us to define the dominant fraction in each layer.

Finally, the morpho-analytical characterization of the litter from two forest groups of the North-East of Algeria shows the dominance of the fraction recognizable on the surface, essentially constituted by leaves and twigs. The latter evolves rapidly under the effect of several climatic, biological and edaphic parameters to give humified fractions where the debris are not or hardly recognizable and which act on the physicochemical properties of the soil particularly: the soil reaction (pH).

The humification and mineralization of this litter brings to the soil a quantity of mineral elements (nutrients) essential to the development of the whole forest ecosystem.

In the absence of silvicultural management, the Algerian forests in general and the North-East zones in particular are maintained by the turnover of organic matter.

To conclude, the National Park of El-Kala (PNEK) is known by the diversity of its ecosystems which are linked to a rich and diversified vegetation cover dominated by forests of cork oak and Zeen oak. This plant cover maintains close relations with the substrate that supports it and offers the soil a quantity of litter that evolves throughout the year to provide the mineral elements that plants need.In order to know these relations, to evaluate and characterize the contributions of litter, we undertook this study in two characteristic groups of the vegetation cover of Ain-Bergougueya.The evaluation and characterization of the litter coming from two groups of oak namely the group of Zeen oak and that of cork oak showed that the contribution is very important under Zeen oak than under cork oak.The reaction of the soil is more acidic under the cork oak because this grouping is characterized by a permanent supply (presence of fresh litter which provides more organic acids), whereas under Zeen oak the supply is limited to a period of the year thus directing the remainder of the year towards the mineralization and humification of the organic matter.

The mineralization of organic matter provides the soil with an important quantity of mineral elements which acts on the soil pH and favors the mineral nutrition of plants.The rapid recycling of organic matter and the use of mineral salts by the plant cover do not allow for their accumulation and results in poorly mineralized soil.The diagnosis that we have carried out at the level of the forest soils of Ain-Bergougueya constitutes an approach that requires more time to follow a complete cycle of renewal of the litter fallout in this region.

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