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Physicochemical and Rheological Properties of "*Bunium bulbocastanum*" Earth-nut Flour

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ABSTRACT

Background: The species of the *Bunium* kinds are aromatic plants with medicinal properties. especially the earth nut. which the fruits are used as aroma.and the leaves and roots consumed as vegetables (Taufel *et al.* 1993). The present study was conducted in order to valorize its roots by studying the physicochemical and rheological properties of its flour.

Methods: The study focuses on tuber nuts from different regions Khenchela. Mostaganem. Relizane.and Tissemsilet (Algeria).and the earth nut roots harvested the months of February (Y-1 2018 and Y 2019). Those latter were initially reduced into smaller particles. followed by milling into flour using a laboratory mill and sieving through a 250-300 µ aperture screen. The flour samples were packed in resealable polyethylene bags. Mix flour is prepared from wheat flour containing varying proportions of BN flour (1. 2. 5. 10. 15. 20. and 50%).

Result: The results made it possible to conclude that this gluten-free flour (BF) contains about 7% of proteins; lipid and ash contents are 3.34% and 3.96% respectively. On the sensory level. the color parameters (L *, a *, b *) conclude that there is a significant region effect and the harvest period on the color of the flour. The results reveal that all earth-nut flour (EN) differ significantly (P≤0.05) in all the chemical properties investigated. The presence of BF improves P when going from 5 to 50% substitution. improves fat rates. However. it has a negative influence on the W energy. the swelling and the P/L ratio of the dough. This study would suggest that earth-nut flour could be suitably incorporated in wheat flour up to 5%, but at higher doses with gluten-free flours. Mean levels of the metals in samples ranged from 62.91 to 80.08 mg/kg with those of Cu and 0.01 mg/kg with those of Pb, Hg.

Key words: *Bunium Bulbocastanum*, Flour, Rheological, Root.

INTRODUCTION

Tubers and roots had been used in human nutrition since ancient times. It seems that since the Second World War and the period of national revolution in Algeria. our parents had been attracted by the (*Bunium bulbocastanum*)nut. which were seduced by its energy supply and its therapeutic use. Known in Algeria by Talghouda or Terghouda; this species comes from the Balearic Islands. from western Central Europe to the northwest of the former Yugoslavia. The fruits are used as herbs and the leaves and roots eaten in vegetables. Its roots grow in the wild.and give a starch-rich tuber, consumed in the raw state or dry and grind to obtain a flour composed of: 15.66% water. 5.5% ash, 7% nitrogenous matter 1.34% fat, 63.2% starch and congeners. 6.4% cellulose (Dugast, 1894).

Bunium bulbocastanum is a medicinalplant growing in the north of Algeria. There aresome preparations in case it is used as an astringent ant diarrhoealfor their virtues. but people almost prefer to consumeit directly without saying that it is properly washed and stripped of the parties Bousetla *et al.* (2011).

Bunium bulbocastanum exhibits antioxidant property related to its antidiabeticproperty is well understood.The results of Hazarika *et al.* (2016) conclude that ethyl acetate and aqueous fraction of *B. bulbocastanum* fruit has a noteworthy antioxidant and an anticancer activity. However. the phytochemical analysis of roots of the plant revealed thepresence of some bioactive compounds (sucrose, oleic acid, scopoletin, scoparone and βsitosterol) Chentouh *et al*. (2017). Studies have shown that replacing part of wheat flour with root flour like sweet potato improves the properties of the the flour and dough and the texture and sensory quality of the beard (Meng *et al* (2020).

This article focuses on the physicochemical and rheological characteristics of the *Bunium Bulbocastanum* flour. as well as the effect of the environment and harvest period on its characteristics.

MATERIALS AND METHODS

The study focuses on tuber nuts from different regions in Algeria (Khenchela, Mostaganem, Relizane and Tissemsilet). Earth nut roots harvested the months of February (Y-1 2018 and Y 2019), they were washed with tap water to remove

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soil particles. The cleaned roots were air dried. peeled manually with stainless steel and sliced into small pieces. Little piece were initially reduced into smaller particles. followed by milling into flour using a laboratory mill (CHOPIN CD1 and CD2); and sieving through a 250-300 µ aperture screen. The flour samples were packed in resealable polyethylene bags. Mix flour was prepared from wheat flour containing varying proportions of BN flour (1, 2, 5, 10, 15, 20, 50%). Methods were used to determine; Moisture (ISO 712, 2009), protein (Kjeldahl method, 1883), fat (Soxhlet method, 1879), fiber (Henneberg et Stohmann method, 1860). Ash (ISO 2171:2007). pH (AFNOR NF ISO 10-390). the samples were analyzed for fat acidity according to (PNISO 7305).

Rheological properties of flour were determined by a Chopin MA 82 alveograph (according ICC Standard 55 30-3). Each alveograph chart was analysed for four factors: P- the maximum over pressure needed to blow the dough bubble-expresses. dough elasticity. L - the average abscissa at bubble rupture-expresses dough elasticity. P/L- alveograph ratio and W - the deformation energy. Flour color was measured in triplicate using a chromameter (model CR210. Minolta. Osaka. Japan) with the granular materials attachment. and brightness (L*), redness (a*), and yellowness (b*) where values were taken.

Heavy metals are defined as metallic elements that have a relatively high density compared to water. Heavy metals like Cu, Pb, Hg are potentially hazardous in combined or elemental forms. Once the heavy metals enter the food chain they may end up accumulating in the human body. Heavy metals above allowable limits will often lead to disadvantageaous effects in humans. (Geoffrey *et al* 2020). Heavy metals of flour were determined by (NF EN 14082/ 2003) to determine the flour toxicity.

The statistical analysis was carried out using (ANOVA) to determine the effect of region. harvest period and incorporation rate in soft wheat flour.

RESULTS AND DISCUSSION

Effects of the environment and harvest period

All earth-nut flour (EN) differ significantly (P≤0.05) in all the chemical properties investigated. Table 1 shows the range of values for proximate composition of flour as affected by region and harvest period. with moisture content (10.13-13.12%). Our results are close to that of (Dugast, 1894), El Kolli *et al.*(2017). In turn, Bakayoko *et al*. (2013) demonstrated in their studies on different varieties of cassava that harvest periods significantly influence average yields and yields. dry matter of tubers, protein (0.9-7.6%). Our results are close to that of (Dugast, 1894), fat (0.73-3.38%). fiber (0.12-0.25%), ash (1.10-3.96%) and Aw (0.35-0.48).

The fat content of earth-nut flour is shown in Table 1. Our result is corresponding with after Dini *et al*. 1994 2.2% lipids of *Lepidiummeyenii* (maca). This flour is a stable product because its water activity (aw) is less than 0.65 (Thebud and Santarius, 1982).

The tristimuluscolor parameter L* indicate whiteness of the flour. as reported by Collado *et al.* (1997). In the present study however. flour from varieties had the least mean L* values (77.75±0.89). This confirms the works of other authors Jangchud *et al.* (2003). which showed that the whiteness of the flour is not always directly related to the flesh color of the roots. They suggested that this is an indication of the high level of browning that occurs during drying of sweet potato chips and processing the flour. It was noted that the values of the redness index of the EN harvested at Relizane and Khenchla in 2018 showed significant differences ($p<0.05$) (1.79% vs. 0.56%). respectively. This is supported by the report of Jangchud *et al.* (2003).

With a crude protein content of about 7%. ground nut flour has a lower value compared to *D. dumetorum* tubers, which is 10%, the latter have the highest protein value compared to other dietary roots and tubers (Agbor-Egbe and Trèche, 1995). The nitrogen content in the genus *Terfezia tirmania*varies between 3.3 to 79% of dry matter. The earth nut tubers have high levels ranging between 0.73 and 3.38% compared to *D. dumetorum* which have very low lipid content. around 0.3 g / 100 g (Agbor-Egbe and Trèche, 1995). This content is comparable to that of other food roots and tubers; 0.4% for potato (Bradbury, 1988), 0.2% for taro (Agbor-Egbe and Rickard, 1990) and 0.3% for cassava (Rickard and Coursey, 1981). Osagie, (1977) measured the phytosterol content of *D. dumetorum*; it is 24 mg / 100 g of

Table 1: Physicochemical composition of different earth-nut flours.

	R (Y-1)	R (Y)	M (Y-1)	M (Y)	T (Y-1)	T (Y)	K (Y-1)	K (Y)
Moisture %	10.13 ±0.268^{d}	13.10±0.83^{a}	12.16±0.23^{b}	10.01±0.17^{d}	12.11±0.05^{b}	10.46±0.16^{d}	10.24±0.13^{d}	11.50±0.32^{c}
Protein %	5.31±0.1^{d}	4.99±0.05^{d}	5.72±0.24^{c}	5.74±0.35^{c}	7.27±0.0^{a}	7.05±0.63^{a}	6.28±0.19^{b}	6.29±0.16^{b}
Fat %	2.32±0.4^{c}	1.13±0.10^{f}	1.43±0.02^{e}	3.34±0.04^{a}	1.02±0.01^{f}	3.01±0.01^{b}	0.73±0.06^{f}	1.63±0.10^{d}
AW	0.38±0.0^{ab}	0.47±0.00^{c}	0.47±0.00^{b}	0.44±0.00^{c}	0.47±0.00^{ab}	0.35±0.00^{d}	0.48±0.00^{ab}	0.48±0.02^{a}
Ash %	3.96±0.05^{a}	1.102±0.18^{e}	1.13±0.05^{e}	1.334±0.01^{d}	1.724±0.023^{b}	1.60±0.06^{c}	1.13±0.045^{e}	1.25±0.03^{d}
FN (sec)	137±0^{d}	132±2.236^{f}	169.2±0.447^{a}	169.2±0.447^{a}	145±0^{c}	135±0^{e}	163±0^{b}	86±0^{g}
Fat acidity (mgH_2SO_4/100 g db)	0.01±0.01^{c}	0.01±0.01^{c}	0.03±0.03^{c}	0.09±0.01^{c}	0.01±0.00^{c}	0.01±0.00^{c}	0.08±0.03^{ab}	0.06±0.0.00^{b}
Brightness (L*)	77.75±0.89^{a}	81.82±1.13^{ab}	82.74±1.17^{bc}	82.01±0.29^{cd}	80.98±0.96^{d}	82.01±0.29^{cd}	84.29±0.91^{a}	83.62±0.3^{ab}
Redness (a*)	1.79±0.20^{a}	0.58±0.19^{c}	0.74±0.13^{c}	0.79±0.05^{c}	1.26±0.02^{a}	0.79±0.05^{c}	0.68±0.06^{c}	0.56±0.07^{c}
Yellowness (b*)	19.93±0.7^{a}	18.94±0.45^{b}	18.12±0.53^{c}	13.96±0.22^{d}	18.86±0.07^{b}	13.96±0.22^{d}	17.74±0.47^{c}	19.39±0.20^{ab}

crude material. Sweet potatoes contain little fat (0.3 - 0.8%) according to Ndangui. 2018.

Substitution in soft wheat flour

Our results reveal that, the physicochemical characteristics of floors composed when goes from 1% to 50% of substitutions. the chemical composition of floors improvesrespectively to ash, unlike to fat, Moisture, FN, and damaged starch (Table 2). By comparing these results with the French standard which requires humidity less than 15.5% for flour. we can say that the samples studied are compliant with the French standard (NF ISO 712.1989) and texts published in the official Algerian journal (JON°91-572, 1991). These values are in the range 12.60-14.70% given by Souci *et al.* (1994) and lower than 13.0% maximum value for Cassava Flour Codex Standard 176-1989, seeing that the moisture content of the flours is decisive for their good storage due to their hygroscopicity; where it is necessary to reduce it to 14%. 12% or even 7% depending on the use (Colas, 1998). In addition. the lower water content of the flour, the more it is possible to hydrate it during kneading to achieve an optimal consistency of the dough (Grandvoinet and Pratx, 1994). It is generally low. between 1.0 and 8.5% (VanHal, 2000). which is in agreement with the values obtained in this study. After adding groundnut flour, the protein level decreased compared to soft wheat flour, but they still comply. We notice from the above results that the Aw goes from 0.58 to 0.56, this indicates that this flour is a stable product. because its water activity (aw) is less than 0.65 (Thebud and Santarius, 1982).

This concept was defined as early as 1953 by W.J. Scott (Scott, 1953) for the food industry in order to qualify the water state of products with intermediate humidity. It is one of the most important properties in the processing. preservation. and storage of food. We quantify the degree of binding of water with the product. and therefore its availability to act as a solvent and participate in chemical. biochemical. and microbiological reactions (Labuza, 1980). As aw increases. the binding energy between water and other molecules decreases. It then becomes more and more available for unwanted chemical reactions; this concerns in particular the phenomena of oxidation and the development of bacteria or fungi. These reactions can then quickly induce degradation or simply accelerated aging of the product (Baldet and Colas, 2012).

Our results reveal that the rheological characteristics of composite flours. when going from 1 to 50% substitution. it has a negative influence on the W energy. the swelling and the P/L ratio of the dough (Fig 1).

Heavy metals content

Heavy metals especially Pb and Cu are relatively less soluble and available for plant uptake, The entrance of metals from soil to roots is not direct; ratherthey are first adsorbed on plant roots, followed by binding to carboxyl groups ofuronic acid around the roots, or directly to the mucilage polysaccharides of the rhizodermcell surfaceMuhammad Shahid *et al.* (2015). The results in Table 3 revealed that environment influences the concentration of Cu in *Bunium Bulbocastanum* root 62.91±02 vs 80.8±02 mg/kg in both Mostaganem and Relizane respectively. The root is characterized by a low content of Pb and Hg <0.01 ±0.00mg/kg. The literature shows that both leafy and nonleafy vegetables are good accumulators of heavy metals. In nonleafy vegetables. the bioaccumulation pattern was leaf > root H" stem > tuber khan *et al.* 2014). The concentrations of heavy Metalsanalyzed were below the maximum allowable limits.the metals were in range that showed no contamination of samples.

Table 2: Characteristics of Earth-nut flour and soft wheat.

	Fresh flour	BN01%	BN02%	BN05%	BN10%	BN15%	BN20%	BN50%
Moisture %	14.63±0.01^{a}	14.02±0.01^{b}	14.00±0.00^{b}	13.81±0.04^{d}	13.89±0.01^{c}	13.89±0.00^{c}	13.65±0.01^{e}	12.58±0.01^{f}
Protein %	11.81±0.01^{a}	11.76±0^{b}	11.60±0.01^{c}	10.92±0^{d}	10.69±0^{e}	10.49±0^{f}	10.48±0.01^{f}	9.31±0.01^{g}
Fat %	3.39±0.01^{ab}	3.32±0.01^{b}	2.91±0.19^{c}	2.78±0.01^{d}	3.46±0.02^{a}	2.72±0^{d}	2.69±0.01^{d}	2.59±0.02^{e}
Ash %	0.51±0.01^{f}	0.72±0.01^{cd}	0.70±0.01^{de}	0.69±0^{e}	0.74±0^{c}	0.78±0.01^{b}	0.87±0^{a}	0.85±0.05^{a}
fiber %	2.49±0.01^{a}	2.49±0.03^{a}	2.37±0.01^{b}	2.37±0^{b}	2.33±0.00^{c}	2.29±0.00^{d}	2.29±0.01^{d}	2.28±0.01^{d}
FN (sec)	251.2±2.16^{a}	250.6±1.34^{ab}	250.4±0.54^{b}	248.6±2.79^{ab}	240±1.22^{ab}	220.8±0.44^{c}	199.4±6.42^{d}	202.6±0.54^{e}
Damaged starch	20.16±0.47^{a}	19.93±0.04^{a}	19.68±0.04^{a}	19.90±0.17^{a}	19.84±0.02^{b}	18.68±0.09^{c}	15.68±0.38^{d}	9.94±0.05^{d}
AW	0.51±0.00^{a}	0.50±0.00^{a}	0.50±0.00^{a}	0.50±0.00^{a}	0.49±0^{b}	0.51±0.00^{c}	0.45±0.02^{c}	0.44±0^{c}

Table 3: concentration of heavy metals content of *Bunium Bulbocastanum* (mg/kg).

	Tissemsilet	Khenchela	Mostaganem	Relizane	Max
Pb	<0.01±0.00^{a}	<0.01±0.00^{a}	<0.01±0.00^{a}	<0.01±0.00^{a}	0.2
Cu	69.65±0.2 ^{b}	68.68±0.2^{b}	62.91±0.2^{a}	80.08±0.2^{c}	150-200
Hg	<0.01±0.001^{a}	<0.01±0.00^{a}	<0.01±0.00^{a}	<0.01±0.00^{a}	0.1

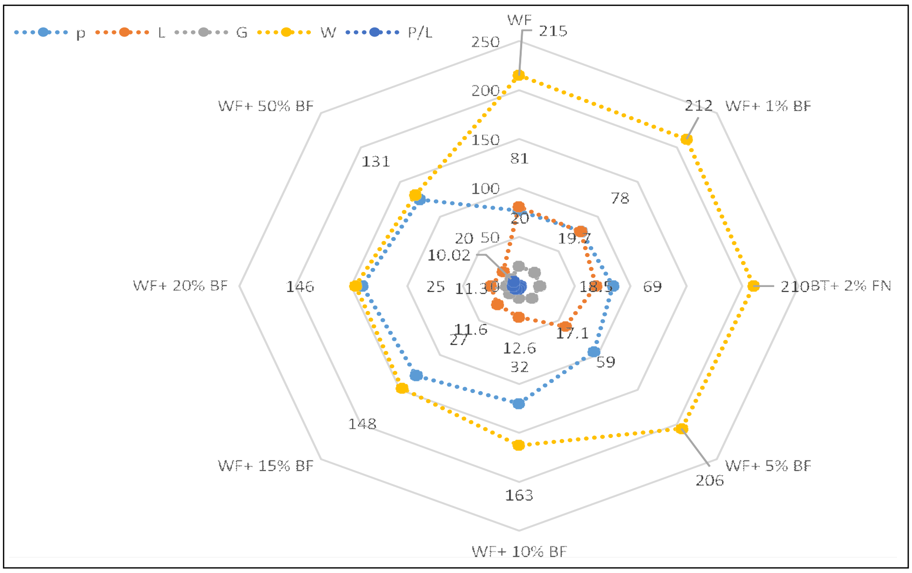

Fig 1: Rheological Characteristic of Earth-nut flour and soft wheat.

CONCLUSION

The present study was conducted in order to valorize the *Bunium Bulbocastanum*, an unknown tuber, by studying on the one hand the physicochemical properties and the technological characteristics of its flours . The results made it possible to deduce that this gluten-free flour is rich in proteins (can reach7%) mainly at Tissemssilet 7.27%, similarly, a high fat content Mostaganem and Tissemssilet samples harvested this year (3.38%. 3.01%). On the other hand. the Relizane sample is marked by its high ash content of 3.96%. This flour is a stable product because its water activity (aw) is less than 0.65 (Thebud and Santarius, 1982).

Our results reveal that the physicochemical characteristics of composite flours (FBT and FNT), when going from 1 to 50% substitution.Improves fat rates, ash tenacity rate and the gluten index. However. it has a negative influence on the W energy, the swelling and the P / L ratio of the dough. The concentrations of heavy Metalsanalyzed (Pb, Cu ans Hg) were below the maximum allowable limits.

This study would suggest that earth nut tubers could be properly incorporated in wheat flour up to 5-10%, but at higher doses with gluten-free flours.It would be better to study the level of polyphenols in *Bunium Bulbocastanum* tuber.

Conflict of interest: None.

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