NUTRITIONAL COMPOSITION, PHYSICAL PROPERTIES AND SENSORY EVALUATION OF BISCUIT PRODUCED FROM JUJUBES (Fruits of *Zizyphus lotus* L.)

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Abstract

Flour blends were produced using wheat and jujube. The jujube/wheat flour was mixed in the ratio 0:100, 25:75, 50:50, 75:25, and 100:0 respectively and used to produce biscuit. Chemical properties of the jujube were determined. Also the produced biscuits were evaluated for physical, chemical and sensory characteristics. Chemical qualities of the jujube showed protein (1.43%), ash (3.20%), Carbohydrate (24.29%), fat (0.84 %), and moisture (3.80-5.80%). The jujube appears to be richer in mineral elements, in mg/100g dry matter (DM), mainly in calcium (650.6), potassium (607.4), magnesium (288.6), phosphorus (101.4), sodium (11.40), the diameter, height, weight and spread ratio of the biscuit ranged from 4.42 to 4.59 cm, 0.60 to 0.86 cm, 9.49 to 10.17 g and 6.30 to 7.60 respectively. The proximate composition of the biscuit ranged in values with moisture from 2.61% to 3.61%, crude protein 11.25% to 12.39%, fat 25.76% to 26.51%, ash 3.03% to 3.31%, carbohydrate 51.73 to 53.24% and the energy value was between 484.40 and 522.95 Kcal. The result of organoleptic analysis revealed that there is a significant difference among the samples in terms of color, taste, crispness, appearance and overall acceptability. All biscuit samples were generally accepted but sample FWW (100% wheat flour) and sample WFJ (50% wheat + 50% Jujube) were most preferred by panelists. Moreover, while additional Jujube flour resulted in a decreased mean score for overall acceptability. All results indicate the possibility of the jujube flour as promising in the formulation of biscuit and open broad prospects in food industries.

Keywords: The jujube, Valorization, Biscuit, Acceptability, Sensory evaluation, Jujube flour, Wheat flour.

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1. INTRODUCTION

The genus *Zizyphus* belonging to the family Rhamnaceae is wide spread in tropical and sub-tropical regions: Asia, Africa, America, Oceania and Europe with the center of diversity in Asia (Richardson et al., 2004). There are 135-170 species of *Zizyphus* (Maraghni et al., 2010). *Zizyphus lotus*. (Desf) is abundantly present in the Mediterranean region like Libya, Algeria, Morocco, Spain, Sicily, Greece and Cyprus (Benammar et al., 2010). In Algeria, we find exclusively the species of *Z. lotus* (L.) (Borgi and Chouchane, 2009). It's the endemic species of the Aures region, northeasterm. It is known in Algria as 'Sedra'. The fruit, called 'Nbag' (Abdeddaim et al., 2014). This plant is known for its several medicinal values as anti-inflammatory and analgesic drug (Borgi et al., 2007), thus, it was used topically as emollient in the treatment of boils and it is described as having an anti-ulcer activity (Le-Floc'h, 1983). Also, in the treatment of diarrhea and intestinal diseases (Boukef, 1986). *Z. lotus* is dormant from October to March and mature plant flowers in May and June and produces fruits in August (Maraghni et al., 2010). The fruits are spherical drupes of which the small and round bilocular bone nuclei are covered with a pulp Half-fleshy, rich in sugar (Ghedira, 2013). Fruit of *Z. lotus* of North Africa is delicious and consumed directly due to its high nutritional value. In fact, Abdeddaim et al. (2014) demonstrated that this organ was rich in minerals (calcium, magnesium, sodium, potassium and phosphorus), carbohydrates, fatty acids and proteins that are essential for some physicochemical processes necessary for a good health. Besides, Benammar et al. (2010) showed that the fruit pulp of this plant

contained a higher vitamin A and C compared to the other parts. The fruit pulp was the richest source of linoleic acid (18:2n−6), a precursor of n−6 fatty acids, and, the leaves were the richest source of vitamin E and linolenic acid (18:3n−3), a precursor of n−3 fatty acids. Ghalem (2014) reports that the pulp is rich in erucic acid and fibers. This spiny shrub is of great economic and ecological interest: it stabilizes sand dunes, and has food, fuel and medicinal uses (Le-Floc'h, 1983; Borgi et al., 2008; Borgi and Chouchane, 2009; Gorai et al., 2010; Maraghni et al., 2010). *Z. lotus* is found in a spontaneous state and adapt to the many soils and climates. Its fruits are highly appreciated by the Algerian population and especially children, but their consumption is seasonal whereas it is possible to obtain many food and/or non-food derivatives. Note that the products based on jujubes have already been developed. Such as jam, syrup, bread called Oufers (Rsaissie and Bouhache, 2002), flour, zemmita, wafer (Ghedira, 2013). It is also used as additive, aromatic compounds for thousands of years (Adzu et al., 2003). Wine (Sudhersan and Hussain, 2003). Bread called Soufer (Goetz, 2009), wafer called awfar (Gast, 2000)
However, not much research has been conducted on the fortification of wheat flour with jujube flour for biscuit, this later are the most popular food consumed by all age groups. Biscuits offer a valuable vehicle as it can be used as a ready form to eat as well as it has a wide consumption and a longer shelf life. Therefore, the objective of this study is to valorize the jujube by trying to formulate a new product of biscuit.

2. MATERIALS AND METHODS

2.1. Plant materiel

The fruits of Z. lotus were collected from Doufana region (Batna, eastern Algeria), in September 2016 and were identified in the Laboratory of Botanic (The agricultural institute of Batna). Edible parts, seeds and almonds were manually isolated, and were stored in paper bags at 4 °C until further use.

2.2. Chemical analysis of fruit

The moisture content was determined by drying a sample of fruit in an oven Memmert SLE 400 at 103 C° until constant weight was reached (AOAC, 1998). Carbohydrate content was examined using phenol-sulphuric acid colorimetric method (Dubois, 1956) using a spectrophotometer (UV-VIS, Shimadzu). Protein content was calculated from the nitrogen content (%N · 6.25) analyzed by Kjeldahl method (AOAC, 1998). Ash was measured according to the standard procedures (AOAC, 1995). Lipid content was determined using a Soxhlet apparatus HT 1034 according to the procedure described by Huang (1989). The mineral constituents (Ca, Mg, P, Mn, Cu, Co and Zn) were analyzed separately according to the AOAC standards (1998), using an atomic absorption spectrophotometer (Agilent AA 240 Fs) with air acetylene, while Na and K were measured by flame photometer.

2.3. Preparation of jujube flour

The jujubes were washed, sliced, sun-dried for 120 h and milled. The flour samples were sieved through a 75 µm sieve and stored in plastic containers.

2.4. Biscuit formulation

Biscuits were made from wheat to serve as a control. The jujube flour was mixed with wheat Flour at different level (25, 50, 75 and 100%) to prepare biscuit. The biscuit were prepared using the following ingredients: flour (200 g), fat (100 g), sugar (50 g), Egg (54 g). The fat was creamed with sugar until fluffy, the other dry ingredients were added. The batter was kneaded on a rolling table to acquire the desired thickness. The batter was later cut to round shape with the aid of biscuit cutter. It was baked in the oven at 200 C° for 20 minutes, cooled and packaged. The flow chart for the production of biscuits is shown in Figure 1.

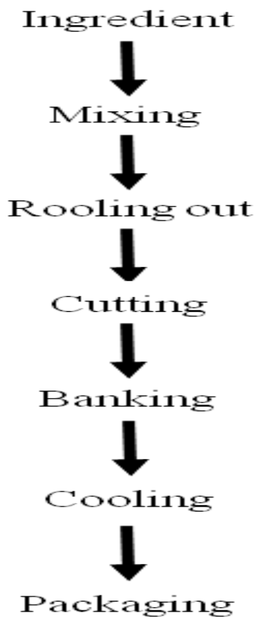

Fig. 1. Flow chart for biscuit production

2.5. Determination of Proximate composition of the biscuit

The moisture, ash, fat, protein contents were determined using AOAC (1998), while the carbohydrate content was quantified using phenol-sulphuric acid colorimetric method (Dubois, 1956), Energy value was calculated using Atwater factors by multiplying the portions of protein, fat, and carbohydrate by their physiological fuel value of 4.0, 9.0 and 4.0 (Pearson, 1979).

2.6. Physical analysis of the biscuits

The weight and diameter of the baked biscuit were determined by a weighing balance and measuring with a calibrated ruler respectively (Ayo et al., 2007). The spread ratios determined using the ratio of diameter to height (Giami et al., 2004).

2.7. Sensory evaluation

This test describes the degree of consumer acceptance and satisfaction regarding biscuit attributes. Biscuit samples were analyzed for sensory characteristics. Sensory quality characteristics were evaluated by a panel of 10 semi-trained members using a 9-point Hedonic scale. where 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely (Lamond, 1977). The biscuits were evaluated for their taste, color, appearance, crispness and overall acceptability.

2.8. Statistical analysis

Data were analyzed with the 2009 XLStat software. The Duncan's test is used to evaluate the significance of differences between mean values at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Proximate composition analysis

The result of proximate composition of the jujube is presented in Table 1. The fruit has a low water content (12.40%) which facilitates their preservation. It showed a higher amount of total sugar content (24.29%) compared to those (10.55%) reported for the same fruit (Abdeddaim et al., 2014). This high content of soluble sugars gives them an appreciable caloric intake, as well as the possibility of transforming them into products (biscuit, syrups, juice, jam, marmalade, jelly ...). The jujube contained relatively low amounts of lipid (0.84%). The lower lipid contents are due to some bound lipids which were not extracted by ether (Ranhotra and Loewe, 1974). The content of protein was 1.43%. These results were nearly with the data (2.10%) found by Ghalem, (2014). The mineral matter present in the jujube is 3.20%, the data indicated that calcium, potassium, Magnesium. Phosphorus, sodium were the major mineral constituents in the jujube. Manganese, zinc, iron, copper and cobalt were also detected in appreciable amounts. In total, the mineral contents could be affected by climate, soil nutrient content, time of harvest. It is not worthy that minerals are important not only for human nutrition, but for plant nutrition as well. In addition, mineral-efficient varieties of plants are more drought resistant and require less irrigation (Bouis, 1996).

3.2. Physical analysis of the biscuits

The physical characteristics (thickness, diameter, weight and spread ratio) of the five types of Biscuit are shown in Table 2. The range of biscuit weight was 9.49 to 10.17 g with maximum value in 100% wheat flour biscuits. The increase in biscuit weight was probably due to the ability of jujube flour to retain oil during baking process (Rufeng et al., 1995). The values for diameter ranged from 4.42 to 4.59 cm. Sample FWW (100% wheat) had the highest value while sample FJJ (100% jujube) had the lowest value. The above variations may be due to gluten content present in the flour. The height of biscuits ranged from 0.60 to 0.86 cm. It increased with the incorporation of flour jujube. Increase in thickness may be due to the decrease in diameter. The changes in diameter and thickness were reflected in spread ratio of biscuit. Reduced spread ratios of fortified biscuits were attributed to the fact that composite flours apparently formed aggregates with increased numbers of hydrophilic sites available that competed for the limited free water in biscuit dough (McWatters, 1978). The spread factor is an indicator of biscuit.

Table 1. Proximate analysis of *Zizyphus lotus* L. fruits.

Parameter	Values
Moisiture (%)	12.40 ± 0.33
Soluble sugars (%)	24.29 ± 0.17
Crud Fats (%)	0.84 ±0.09
Crud protein (%)	1.43 ± 0.18
Ash (%)	3.20 ± 0.32
Ca (mg/100g MS)	650.6± 4.45
Co (mg/100g MS	0.01 ± 0.00
Cu (mg/100g MS)	0.03 ± 0.00
Fe (mg/100g MS)	2.50 ± 0.01
K (mg/100g MS)	607.40 ± 1.03
Mg (mg/100g MS)	288.6 ± 0.26
Mn (mg/100g MS)	1.24 ± 0.50
Pb (mg/100g MS)	5.8 ± 0.55
Zn (mg/100g MS)	1.93 ± 0.52

3.3. Chemical composition of biscuits

The results obtained are shown in Table 3. The moisture content of the jujube/wheat biscuits ranged from 2.61% to 3.61%. Significant differences exist in the moisture content of the Biscuit there was a general decrease in the moisture content of the biscuits whenever we increase the addition of jujube flour. Wade and Staffor (1968), reported that the moisture content of different biscuits vary according to the type of biscuit produced, for example cream crackers has about 4.3% moisture content while digestive has about 4.5%. The protein content of all the flour blends differed significantly ($p < 0.05$) form each other. The differences were observed because the protein content of the blends increased steadily with increasing content of jujube flour. The level of the crude protein and fat are within similar ranges for all the samples. The biscuit produced from a blend of wheat flour and jujube flour is expected to be better in terms of protein quality since the jujube has adequate quantity of many amino acids such as cysteine, glycine, arginine, serine, alanine, histidine and leucine (Abdeddaim et al., 2014); the latter is being one of the essential amino acids. The fat content followed the same trend as crude protein. The highest value of 26.51% was recorded for the sample FWW (100% wheat) while the lowest value of 25.76% was obtained for the sample FJJ (100% jujube biscuit). Fat plays an important role in the life span of food products. High fat content in food products tends to deteriorate quickly (Ihekoronye and Ngoddy, 1985). The carbohydrate content increased with an increase in the percentage of jujube flour. This is expected because the jujube has carbohydrate as its highest constituent. The energy value ranged between 484.40 and 522.95 kcal. The protein, fat and carbohydrate constituents of the flours contributed to know the calorie content of the biscuit. Biscuit is an energy food which is taken mostly in food by both young and old person. The addition of jujube flour should help boosting the level of protein quality of biscuit. The ash (%) ranged between 2.34% and

4.19% and this showed a corresponding increase in the proportion of jujube flour. Jujube has relatively higher ash than wheat flour. This could justify the results obtained for the different biscuit sample. This observation can be supported by the findings of Mepba et al., (2007). It follows then that incorporation of jujube flour in the production of biscuits could enhance the mineral intake of many people. Ash is an indicative of the amount of mineral contents in any food sample. Nutritionally this means that, when used as composite flour, it will improve the ash content of the product.

3.4. Organoleptic properties

The organoleptic properties of the biscuit are presented in Table 4. The photographs of biscuit products are presented in Figure 2. The scores for color ranged from 8.30 to 5.27. Sample FWW (100% wheat) had the highest value (8.30) while the FJJ (100% jujube) had the least value (5.27). However, the sample FWW was most preferred in terms of color. Darkness in the samples increased with the increase in jujube content of biscuits. In terms of appearance, FWW (100% wheat) and WFJ (50% jujube) are the most preferred with the score of 7.50, 7.45 respectively, while FJJ (100% jujube) is the least preferred with a score of 6.09. In terms of taste, significant increase in mean scores was noted up to 50% addition of jujube flour into the composite biscuit. The sensory score for taste decreased after 50% addition of jujube flour. This may be due to bitter after the taste of jujube flour. In overall acceptability, sample FWW (100% wheat flour) and sample WFJ (50% jujube) are the most acceptable, while FJJ (100% jujube flour) is least preferred. The overall acceptability score indicated that the biscuit prepared up to 50% jujube flour had most acceptable sensory attributes. According to these results the biscuit produced from 100% wheat and 50% jujube are the most acceptable.

Table 2. Physical properties of Biscuit

Sample	Diameter (cm)	Height (cm)	Weight (g)	spread Ratio
FWW	4.59 ± 0.24^a	0.60 ± 0.03^c	9.49 ± 0.56^c	7.60 ± 0.70^b
FWJ	4.53 ± 0.34^a	0.64 ± 0.02^c	9.62 ± 0.08^b	7.18 ± 0.46^b
WFJ	4.50 ± 0.66^a	0.75 ± 0.03^b	9.89 ± 0.09^{ab}	6.66 ± 0.86^a
FJW	4.45 ± 0.35^a	0.81 ± 0.07^a	9.93 ± 0.09^a	6.42 ± 0.45^a
FJJ	4.42 ± 0.16^a	0.86 ± 0.03^a	10.17 ± 0.11^a	6.30 ± 0.18^a

Values are mean ± standard deviation of triplicate. Means in column with different superscript are significantly different ($p<0.05$).

Key: - FWW=100% wheat flour + 0% jujube flour.
- FWJ= 75% Wheat flour + 25% jujube flour.
- WFJ=50% Wheat flour + 50% jujube flour.
- FJW=25% Wheat flour + 75% jujube flour.
- FJJ=0% Wheat flour + 100% jujube flour.

Table 3. Chemical composition of biscuits

Sample	Moisture	Carbohydrate (%)	Fats (%)	protein (%)	Ash (%)	Energy (Kcal)
FWW	3.61 ± 0.30^a	51.73 ± 0.86^d	25.76 ± 0.43^c	11.49 ± 0.22^b	2.34 ± 0.24^c	484.40 ± 5.53^d
FWJ	3.45 ± 0.59^a	53.24 ± 0.53^c	26.13 ± 0.17^{abs}	12.24 ± 0.25^a	3.32 ± 0.24^b	497.10 ± 2.89^c
WFJ	3.27 ± 0.17^{ab}	57.03 ± 0.74^b	26.41 ± 0.42^{ab}	12.39 ± 0.25^a	3.51 ± 0.25^b	515.46 ± 5.78^b
FJW	2.99 ± 0.49^{bc}	58.58 ± 0.56^a	26.51 ± 0.28^a	12.35 ± 0.97^a	3.60 ± 0.33^b	517.45 ± 4.78^b
FJJ	2.61 ± 0.55^c	59.43 ± 0.80^a	26.08 ± 0.36^{bc}	11.25 ± 0.45^b	4.19 ± 0.24^a	522.95 ± 5.36^a

Values are mean ± standard deviation of triplicate. Means in column with different superscript are significantly different ($p<0.05$).

Key: - FWW =100% wheat flour + 0% jujube flour.
- FWJ= 75% Wheat flour + 25% jujube flour.
- WFJ=50% Wheat flour + 50% jujube flour.
- FJW=25% Wheat flour + 75% jujube flour.
- FJJ=0% Wheat flour + 100% jujube flour.

Table 4. Sensory characteristic of biscuits

Sample	Color	Taste	Crispness	Appearance	Overall Accept.
FWW	8.30 ± 0.42^{a}	8.20 ± 0.70^{a}	7.80 ± 1.00^{a}	7.50 ± 0.68^{a}	7.88 ± 0.78^{a}
FWJ	6.72 ± 1.55^{b}	7.00 ± 1.09^{b}	7.18 ± 1.25^{a}	7.27 ± 0.46^{b}	7.04 ± 1.14^{ab}
WFJ	7.18 ± 1.11^{b}	7.45 ± 0.82^{ab}	7.36 ± 0.80^{a}	7.45 ± 1.43^{ab}	7.36 ± 1.05^{ab}
FJW	5.36 ± 1.36^{c}	5.54 ± 1.63^{c}	6.00 ± 1.61^{b}	6.45 ± 1.75^{c}	5.84 ± 1.61^{c}
FJJ	5.27 ± 1.54^{c}	5.27 ± 1.10^{c}	5.36 ± 1.12^{b}	6.09 ± 1.57^{c}	$5.50^{c} \pm 1.37^{c}$

Values are mean ± standard deviation of triplicate. Means in column with different superscript are significantly different ($p<0.05$).

Key: - FWW =100% wheat flour + 0% jujube flour. - FWJ= 75% Wheat flour + 25% jujube flour.
- WFJ=50% Wheat flour + 50% jujube flour. - FJW=25% Wheat flour + 75% jujube flour.
- FJJ=0% Wheat flour + 100% jujube flour.

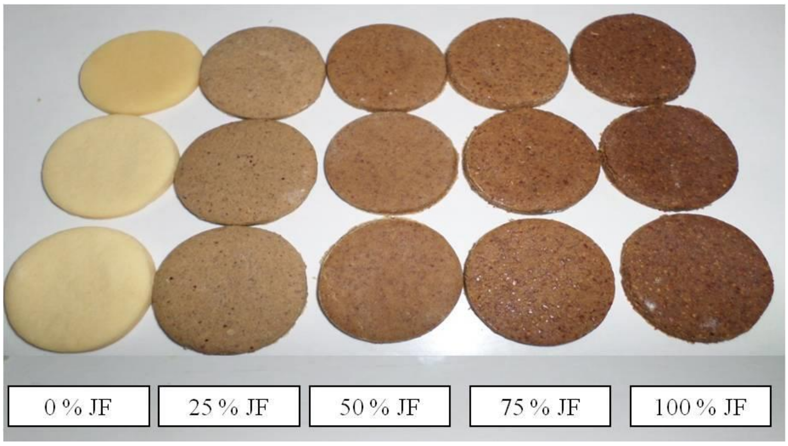

Fig. 2. Biscuits with different level of flour jujube

4. CONCLUSION

The proximate composition showed that jujube has a significant nutritional influence on the biscuit most especially the protein content, which was highest in the sample JFW (75% jujube flour). Also these biscuits prepared from jujube and wheat were appreciable in terms of sensory analysis and had lower moisture, fat, and calorie content. They were also soft and appealing in color.

Biscuit consumption is high in Algeria; therefore jujube biscuit will serve as a vehicle for increasing intake of protein, fat and calories. Their use would go along in reducing dependency on wheat flour in countries that import wheat.

This work paves the way for manufacturers to produce this biscuits and to think in producing other foods (jam, yoghurt and dessert cream) based on this fruit on an industrial scale and encourages farmers to save biodiversity of jujube heritage.

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