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Abstract:

The current study was aimed to produce an acceptable herbal bakery product such as toast bread using Alhagi maurorum powder at different ratios, (2.5, 5, 7.5 and 10%). The chemical composition and minerals content of raw materials and processed toast bread samples were determined. Rheological characteristics of this treated dough, sensory evaluation, the obtained results indicated that Alhagi maurorum powder contained high amounts of protein and crude fiber, besides some essential minerals namely Calcium, Phosphorous and Iron. Alhagi maurorum powder addition significantly ($p < 0.05$) increased the fiber (0.22% to 1.49 %), ash (0.41% to 1.60%) and lipids (5.62% to 7.79%) while decreasing moisture content (11.36% to 11.00%), protein (10.47 % to 9.71%) and carbohydrates (72.14% to 69.66%). Alhagi maurorum there was a significant ($p < 0.05$) increase in Zinc (Z), Calcium (Ca), potassium (K) , phosphor (P)and iron (Fe) from 1.30 to 1.63mg/100g, 45.90 to 281.45mg/100g, 172.08 to 241.25mg/100g , 67.44 to 89.08mg/100g and 6.60 to 7.85 mg/100g respectively, Rheological properties showed that addition of Alhagi maurorum powder negatively affected on some farinograph and extinsograph values Sensory evaluation showed that although there was a significant ($p < 0.01$) improvement in nutritional composition, the acceptability of all bread samples decreased with an

increasing Alhagi maurorum powder. Generally, it could be said that it is possible to produce acceptable herbal bakery products such as toast bread using Alhagi maurorum powder with ratios of 2. 5 and 5%. Alhagi maurorum powder is considered a rich source of Zn, K, Ca, P and Fe could be used to prepare many bakeries products, but there is a need to carry out more studies to evaluate these minerals bioavailability.

Keywords: Bread, Alhagi maurorum, sensory evaluation, rheological properties, chemical composition.

Introduction:

Bread is the main dietary source in many countries; however, wheat bread is the most popular due to its textural and sensory properties according **Ngozi (2014).** Nowadays, consumers increasingly require foods with functional properties. To meet consumer health requirements, the use of functional ingredients in bread formulations is increasingly expanding in the bakery industry as part of bread nutritional improvement as reporting by **Alam et al., 2013.**

Das et al. (2012) confirmed that herbal addition of white bread is a new trend to improve its nutritional value. Herbs are rich in minerals, vitamins, and natural antioxidants.

Alhagi maurorum: Alhagi maurorum is basically an Arabic name and its vernacular name is Al-Agool, Shouk Aljemal, and common name is Camelthorn. It is commonly called as Akool, Camelthorn, Persian Manna plant in Iraq, Saudia Arabia, and Persia, respectively According by **Neamah (2012).**

Various studies have shown that A. maurorum has been used in folk medicines. where the pharmacological properties of Alhagi have been confirmed by in vivo and in vitro studies. These include anti-inflammatory, antioxidant, and cytotoxic effects. Tarangabin is a kind of manna obtained from A. maurorum. Some of its properties, as listed in the Institute of Tropical Medicine Antwerp (ITM) literature, include laxative, detergent, purgative for yellow bile, cough reliever, thirst quencher, antipyretic, antiemetic, and warming agent of the body. Due to their vast geographical distribution and therapeutic effects described in the ITM **(Thompson et al., (2002) Marashdah and Al-Hazimi (2010) & Awaad**

et al., (2011) & Sulaiman (2013) & AE (2015). Ahmed et al., (2015 & Rehman et al., (2015) Tavassoli et al., (2020).

Tavassoli et al. (2020) reported that phytochemical studies have revealed the presence of many compounds in the Alhagi species. Most of these compounds are sugars, polyphenols, flavonoids, essential oil, alkaloids, and other compounds.

The mixture of wheat with Alhagi maurorum powder could therefore significantly improve the nutritional quality of the composite flours, especially in micro-nutrients. This study was therefore carried out to assess the possibility of producing acceptable bread with enhanced nutritional value by a mix of wheat flour with Alhagi maurorum powder.

Materials and Methods: -

Materials: -

Camel thorn plant (A. maurorum) was collected in a semi-desert area north south of ُ Nag Hammadi city, Qena, Egypt in summer season 2020. The whole parts of A. maurorum were collected, washed three times with tap water and two times with distilled water, dried in the shade, and milled to fine powder by Wiley (Model 4- GMI, Germany. Powder of plant was stored in brown glass jars to Determination chemical composition of plant and other analyses

Wheat flour (72%) extract was purchased from a hypermarket, Nag Hamady city, Egypt. Salt, dry yeast, bread improvers, sugar and corn oil were bought from local market, Nag Hammadi city, Egypt.

Methods:

Alhagi maurorum was washed using distilled water and divided into different portions for drying. Then, they were dried using a microwave sharp oven model (R75MRW) at 300Watt output power for 3 min. as described by **Sengev et al., (2013)** & **El-Gammal et al., (2016).** At last, dried leaves were milled and packed into tight polyethylene paper until further use and analysis were carried out

Preparation of toast bread

The flour mixtures used to produce bread samples were prepared according to the ratios as follows:

Control A: 100g wheat flour only.
Sample B:97.5g wheat flour +2. 5g Alhagi maurorum powder.
Sample C:95g wheat flour + 5g Alhagi maurorum powder.
Sample D:92.5g wheat flour + 7.5g Alhagi maurorum powder.
Sample E:90g wheat flour + 10g Alhagi maurorum powder

Baking process of Toast bread:

Toast bread baking using the straight method was carried out as described by **Lazaridou et al., (2007).** Bread dough was baked at 240°C for 20-25 min. in an electric oven (Mondial Formi, 4T 40/60, Italy). The resulted pan bread samples were allowed to cool at room temperature for 2 hours before being packed in polyethylene bags and stored at room temperature for further examinations.

Chemical composition of raw materials and processed toast bread samples:

Moisture, fat, ash, Crude protein and crude fiber were determined using **AOAC (2012)** method. While carbohydrate content was calculated by subtraction according to the following equation: Carbohydrate % = (100 - Moisture% +ash% +fat% +crude protein% +crude fiber%).

Mineral’s content:

Mineral’s content of raw materials and treated pan bread samples were determined. Potassium, Phosphorus, Calcium, Zinc, and Iron were determined using **AOAC (2012)** method.

Rheological measurements dough:

Rheological measurements were carried out for flour mixtures using farinograph and extinsograph tests as described by **Borune (2003) & AACC (2002).**

Sensory property of toast bread:

Toast bread was cooled for 1-2 at room temperature (25º C) in sealed plastic bag. The toast bread was then cut into 2×3×5 cm slices using a bread knife. Sensory properties were evaluated for crust color, irregular shape, crumb color, crumb hardness, taste and flavor, overall acceptability as described by **AACC (2005)**

Statistical Analysis: -

Statistical analysis was carried out using Statistical Package for the Social Science (SPSS) for windows. Version 25 (SPSS Inc., Chicago, IL, USA). Collected data was presented as mean ± standard deviation (SD). Analysis of Variance (ANOVA) test was used for determining the significances among different groups according to **Dowdy et al., (2004)** All differences were considered significant if P 0.05.

Results and Discussion

Effect of Alhagi maurorum powder addition on chemical composition and minerals content of wheat and Alhagi maurorum:

Effect of addition Alhagi maurorum powder on the proximate chemical composition of processed tost bread samples was studied and the results are presented in Table (1). It could be easily observed that lipids, crude fat and ash contents were gradually increased with an increase of Alhagi maurorum powder ratios. Whereas moisture and carbohydrates contents were gradually decreased. The moisture content of many foods is usually considered as an indicator of food quality and shelf life. It is important to measure the moisture content of bakery products because of their potential effect on the sensory, physical, and microbial properties of such products. The obtained data showed that moisture content was gradually decreased from 11.36% in the control bread sample to 11.00 % in E sample, the low moisture content in Alhagi maurorum powder used in the bread blends might have effective implications in texture and microbiological quality of bread processed. according to **Summaya et al., (2016).**

Data found decreased of protein, total carbohydrates, and energy (K cal/100 g) compared with control. On the other hand, result recorded highest value of energy in toast mixed by 2.5% Alhagi maurorum flowed by toast mixed by 7.5 % Alhagi maurorum. The least value of energy found in toast mixed by 5% Alhagi maurorum. In any case, fortifying wheat flour with percentages of Alhagi flour leads, of course, to an improvement in the quality and quality of protein as reporting by **El-Absy (2018).**

Data in Table (2) represented that minerals content (Zn, K, Ca, P and Fe) of different processed pan bread samples with the addition of Alhagi maurorum powder resulted in the high content of minerals. Also, it could be observed that all processed bread samples were superior in zinc, Potassium, Calcium, Phosphorus, and Iron compared with the control sample. Meanwhile, results recorded highest value of Zn in toast mixed by 7.5 and 10% Alhagi maurorum this is due to its increase in Alhagi flour compared to wheat flour. **Abdel-aal et al., (2011).**

From a nutritional view, processed toast bread samples contained higher content of studied minerals. For example, pan bead sample E contained Zn, K, Ca, P and Fe contents 1.63, 218.01, 281.54, 89.08 and 7.85 times than those in the control bread sample.

Table (1): Proximate chemical composition content of wheat and Alhagi maurorum flours

Concentration of blend		**Moisture**	**Ash**	**Protein**	**lipids**	**Fiber**	**Total carbohydrates***	**Calorie value**
Wheat flour	**Alhagi flour**	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
100%	**0%**	11.36 a ± 1.20	0.41 c ± 0.08	10.47 a ± 1.47	5.62 b ± 0.72	0.22 c ± 0.09	72.14 a ± 2.35	381.02 c ± 12.56
97.5 %	**2.5%**	11.03 a ± 2.30	0.50 c ± 0.02	10.21 a ± 1.90	7.23 a ± 0.72	0.40 c ± 0.04	71.03 b ± 1.89	390.03 a ± 13.78
95%	**5%**	11.22 a ± 2.10	1.15 b ± 0.01	10.21 a ± 2.56	6.06 b ± 0.72	0.94 b ± 0.06	71.36 b ± 2.69	380.82 d ± 10.59
92.5 %	**7.5%**	11.00 a ± 1.90	1.25 ab ± 0.01	10.30 a ± 1.36	7.79 a ± 0.72	1.49 a ± 0.50	69.66 c ± 3.59	389.95 b ± 19.23
90%	**10%**	11.00 a ± 1.70	1.60 a ± 0.03	9.71 a ± 1.79	6.24 b ± 0.72	1.01 b ± 0.06	71.45 b ± 4.69	380.8 d ± 20.68
F		0.30	15.1	0.92	9.15	15.1	31.47	688.73

		2			2		
Sig.	0.88	0.00	0.47	0.00	0.00	0.00	0.00
	**	**	**	**	**	**	**

***** Carbohydrates were calculated by difference:

Values are expressed as mean ± SD

**Values at the same columns with different letters are significance at P < 0.1

Table (2): Mineral content (%) of wheat and Alhagi maurorum flour

Concentration of blend		**Minerals**				
		Zn	**K**	**Ca**	**P**	**Fe**
Wheat flour	**Alhagi flour**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
100%	**0%**	1.30 a ± 0.65	172.08 e ± 11.63	45.90 e ± 6.32	67.44 e ± 3.69	6.60 b ± 0.63
97.5%	**2.5%**	1.32 a ± 0.63	178.46 d ± 15.68	91.90 d ± 8.54	70.76 d ± 10.54	7.11 ab ± 0.65
95%	**5%**	1.35 a ± 0.39	241.25 a ± 18.39	185.96 c ± 5.69	79.13 c ± 6.54	7.51 a ± 0.58
92.5%	**7.5%**	1.63 a ± 0.48	201.03 c ± 20.14	191.25 b ± 7.56	83.14 b ± 8.56	7.71 a ± 2.61
90%	**10%**	1.63 a ± 0.38	218.01 b ± 22.65	281.54 a ± 9.24	89.08 a ± 9.36	7.85 a ± 1.25
F		0.33	9277.21	97361.41	898.15	2.93
Sig.		0.86	0.00	0.00	0.00	0.04
		**	**	**	**	**

* Values are expressed as mean ± SD

**Values at the same columns with different letters are significance at P < 0.1

Rheological measurements: Effect of Alhagi maurorum powder addition on farinograph parameters of processed toast bread:

Dough rheological properties are important for their effect in bread quality due to their significant effect on final loaf volume. The rheological behavior of the dough prepared with the addition of Alhagi maurorum powder and wheat flour was determined by farinograph and the results are presented in Table (3) and Figure (1) showing water absorption, arrival time, dough development time and dough stability. Strong flour should have a higher water absorption value than weak flour to help produce good bread properties that remain soft as long as possible. Obtained results revealed that water absorption % increased in all toast bread treatments compared with the control sample (63.50%).

Rakszegi, et al. (2014) reported that water absorption percentages were influenced by soluble protein and damaged starch content. Whereas arrival time (min.) characterizes farinograph mixing properties of flour mixtures. The lowest arrival time was in the control sample recorded 1.00 min. and Alhagi maurorum powder 2.5% addition helped to raise this value.

Dough development time is defined as the time (min.) to be needed to mix flour and water to form a dough with suitable consistency. Dough development time sharply increased in treated toast bread samples, especially in B, D and E samples with increasing in Alhagi maurorum ratios (2.00 min.). while Dough development time sharply decreased in treated toast bread samples, especially in C (1.50min).

The dough stability is reflected also by the degree of softening. For doughs with 10% of Alhagi maurorum fibers, the degree of softening could not be determined because the time of testing was too short, the instruments could not register for such a long time. The dough with Alhagi maurorum fibers had a very long development time and very good stability and the degree of softening could not be measured these results agree with data obtained by **Ognean et al., (2011).**

Table (3): Farinograph parameters of different processed bread samples.

Concentration of blend		**Index of Farinograph**				
Wheat flour	**Alhagi flour**	**Water absorption%**	**Arrival Time**	**Dough Development**	**Stability time**	**Degree of Softening**
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
(A)100%	**0%**	63.50 e ± 9.25	1.00 a ± 0.02	1.50 a ± 0.05	5.00 d ± 0.60	50.00 b ± 3.56
(B) 2.5%	**2.5%**	64.50 d ± 8.54	1.50 a ± 0.01	2.00 a ± 0.10	2.00 e ± 0.70	70.00 a ± 6.32
(C) 95%	**5%**	66.00 c ± 9.36	1.00 a ± 0.01	1.50 a ± 0.07	9.00 c ± 0.57	50.00 b ± 8.21
(D) 92.5%	**7.5%**	67.00 b ± 4.25	1.00 a ± 0.03	2.00 a ± 0.06	12.00 b ± 0.35	40.00 c ± 3.20
(E) 90%	**10%**	68.00 a ± 6.35	1.00 a ± 0.05	2.00 a ± 0.09	15.00 a ± 0.63	0.00 d ± 0.00
Sig.		38.00	0.57	0.86	312.00	7657.14
F		0.00	0.69	0.50	0.00	0.00
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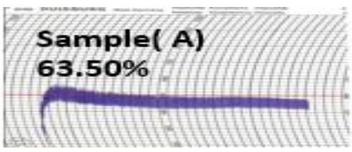
Values are expressed as mean ± SD

**Values at the same columns with different letters are significance at P < 0.1



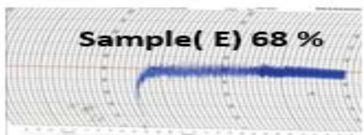


Figure (1): Farinograph parameters of different processed bread samples.

Effect of Alhagi maurorum powder addition on extinsograph parameters of processed toast bread:

Extinsograph analysis gives information about the viscoelastic behavior of a dough and measures dough extensibility and resistance to extension. A combination of good resistance and good extensibility results in desirable dough properties as reporting by **(Rosell and Rajas, 2001** & **Zalatica et al., (2012).** Extinsograph parameter in Table (4) The extensibility of the dough was increased from 140 mm for the control sample to 170 mm dough samples contained 2. 5 % Alhagi. On the other hand, the energy of the dough (area under the curve) (Cm3), were decreased to 50 and 50 Cm3 for dough samples containing 2. 5 and 5% Alhagi compared to control (80Cm3). Also, it was also noted that when increase the Elasticity of dough increases of the Proportional Number.

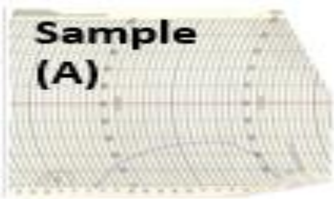
Tabulated results indicated that the control bread sample had the lowest value of elasticity (270 B.U.), while sample E (+10%) had the highest value (880 B.U.). Elasticity value gradually increased with increasing of Alhagi maurorum powder ratios (E>D>C>B). As for extensibility value (mm), it dramatically decreased with the increase of addition ratios, where it recorded 170 mm in sample B and 100 mm in sample E. Consequently, a proportional number which calculated from elasticity and extensibility values, recorded different values. The highest value was 8.80 in sample E, while the least value was 1.92 in sample A. Finally, dough energy (Cm3) is the work input needed to refer to the bread crumb volume. Sample E had the highest value being 120.00 (Cm3), meanwhile, sample B had the least value recorded 50.0 (Cm3). The same manner observed in elasticity was in dough energy. These results are in accordance with those of **El-Karamany (2015).**

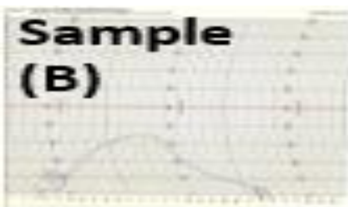
Table (4): Extinsograph parameters of different processed bread samples.

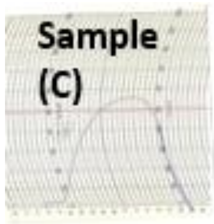
Concentration of blend		Index of Extinsograph			
Wheat flour	**Alhagi flour**	**Elasticity**	**Extensibility**	**Proportional Number (P.N)**	**Energy**
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
(A) 100%	**0%**	270.00 e ± 11.25	140.00 b ± 9.51	1.92 d ± 0.50	80.00 b ± 10.36
(B) 2.5%	**2.5%**	340.00 d ± 18.32	170.00 a ± 9.54	2.00 d ± 0.36	50.00 d ± 9.62
(C) 95%	**5%**	560.00 c ± 20.54	130.00 c ± 8.25	4.30 c ± 0.47	50.00 d ± 9.37
(D) 92.5%	**7.5%**	640.00 b ± 17.32	120.00 d ± 7.26	5.33 b ± 0.73	60.00 c ± 8.62
(E) 90%	**10%**	880.00 a ± 18.29	100.00 e ± 6.35	8.80 a ± 0.64	120.00 a ± 10.56
Sig.		682514.29	7657.14	91.77	9942.86
F		0.00	0.00	0.00	0.00
		**	**	**	**

Values are expressed as mean ± SD

**Values at the same columns with different letters are significance at P < 0.1







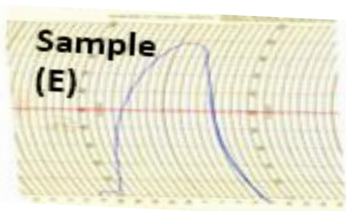


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Figure (2): Extinsograph parameters of different processed pan bread samples

Sensory characteristics of toast bread mixed with 2.5, 5, 7.5, 10% Alhagi maurorum: -

Sensory evaluation of toast bread samples as affected by different ratios of Alhagi maurorum powder was presented in Table (5) and Figure (3). Tabulated data revealed that all sensory attributes of bread samples were decreased by increasing Alhagi maurorum powder ratios. For example, there were significant differences at $P<0.01$ between the control sample and +2.5%, +5%, +7.5% and +10% samples in descending order in all sensory properties. Taste scores of bread samples ranged from16.00 to 19.50 in +20% and control samples, respectively. The same manner was seen in general appearance, distribution of crumb, crust color, crumb color and flavor (12.80-14.00, 13.00-15.00, 12.80-14.00,13.00-15.00 and 16.50-19.00 respectively).

It could be noticed that there was a reverse relationship between Alhagi maurorum powder ratio and overall acceptability, the total score of studied bread samples. The highest value of overall acceptability and total score were 16.00 and 96.50, respectively. The least values observed in the + 10% bread sample were more than 50% of the total score (70.3%, 84.1%, respectively). Figure (3) showed the general appearance of toast bread samples as affected by adding different ratios of Alhagi maurorum powder. The decreased sensory attributes of bread samples with Alhagi maurorum powder may be due to the color and odor of the dried green leaves. These previous results were in good agreement with those obtained by **Sengev et al., (2013).**

Table (5): Sensory evaluation of toast bread samples as affected by addition of Alhagi maurorum powder.

Concentration of blend		General appearance (15)	Curst color (15)	Crumb Color (15)	Distribution of crumb (15)	Flavor (20)	Taste (20)	overall acceptability (20)	Total (100)
Wheat flour	Alhagi flour	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
100%	0%	14.00 ^{a} ± 2.45	14.00 ^{a} ± 3.58	15.00 ^{a} ± 3.25	15.00 ^{a} ± 1.23	19.00 ^{a} ± 1.52	19.50 ^{a} ± 1.59	16.0 $^{a.}$ ±2.21	96.50 ^{a} ± 3.25
97.5%	2.5%	13.80 ^{ab} ± 1.36	13.80 ab ± 2.36	14.80 ab ± 3.69	14.80 ^{ab} ± 2.25	17.80 ^{b} ± 2.47	17.00 ^{b} ± 1.87	15.33^{ab} ±1.89	92.00 ^{b} ± 6.58
95%	5%	13.50 ^{abc} ± 1.51	13.50 ^{abc} ± 2.69	14.00 C± 1.53	14.00 ^{bc} ± 1.17	17.20 ^{bc} ± 2.14	16.80 ^{bc} ± 2.36	14.83^{b} ±1.36	89.00 ^{c} ± 9.54
92.5%	7.5%	13.00 ^{bc} ± 1.29	13.00 ^{bc} ± 3.54	13.80 cd ± 2.56	13.50 ^{cd} ± 1.59	17.00 ^{bc} ± 2.56	16.50 ^{bc} ± 0.72	14.46^{bc} ±1.64	86.80 ^{d} ± 8.64
90%	10%	12.80 ^{c} ± 3.05	12.80 ^{c} ± 9.24	13.00 ^{d} ± 2.87	13.00 ^{d} ± 1.50	16.50 ^{c} ± 3.21	16.00 ^{c} ± 0.94	14.06^{c} ±1.58	84.10 ^{e} ± 7.14
F		2.99	2.99	7.45	8.21	10.51	21.18	16.38	262.25
Sig.		0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00
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Values are expressed as mean ± SD

**Values at the same columns with different letters are significance at $P < 0.1$

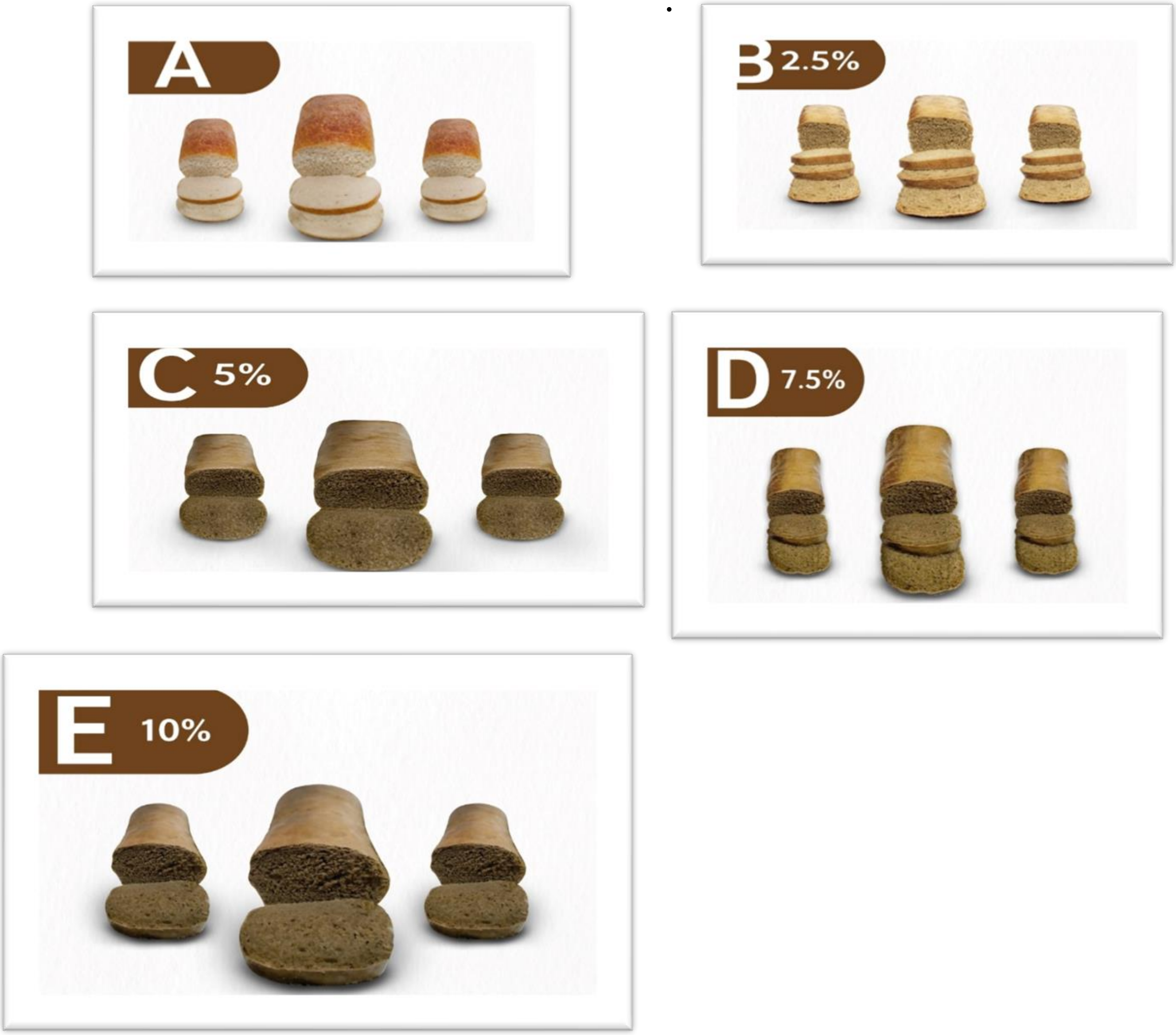

Figure (3). General appearance of toast bread samples as affected by adding different ratios of Alhagi maurorum

CONCLUSION

Finally, it could be concluded that it is possible to produce herbal bakery products such as toast bread using Alhagi maurorum powder with ratios of 2. 5 and 5%. The results also indicated that there was a reverse relationship between Alhagi maurorum powder ratio and all sensory attributes value, thus it is recommended to add some improvers or flavor enhancers to raise these quality attributes. Alhagi maurorum powder is considered as a rich source of Ca, Mg and Fe, could be used to fortify many bakery products, but there is a need to carry out more studies to evaluate these minerals bioavailability.

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تأثير مسحوق العاقول (شوكة الجمل) في بعض الخصائص الكيميائية والحسية لخبز التوست

الملخص العربى

هدفت الدراسة الحالية لانتاج منتج مخابز عشبي مقبول مثل الخبز التوست باستخدام مسحوق العاقول بنسب مختلفة (2.5 ، 5 ، 7.5 و 10٪). تم تقديركلا من التركيب الكيميائي ومحتوى بعض المعادن فى المواد الخام وعينات الخبز التوست المصنع. تم تقدير كلا من الخواص الريولوجية لعجائن هذه المعاملات، التقييم الحسي ،وقد اشارت النتائج الى أن مسحوق العاقول يحتوي على كميات مرتفعة من البروتين والألياف الخام ، بجانب بعض العناصر المعدنية الهامة مثل الكالسيوم والفوسفور والحديد. أدت إضافة مسحوق العاقول إلى زيادة معنوية($p < 0.05$) . كما اظهرت النتائج ان اضافة مسحوق العاقول قد رفعت كمية الألياف من(0.22٪ إلى 1.49٪) والرماد من (0.41٪ إلى 1.60٪) والدهون من (5.62٪ إلى 7.79٪) مع انخفاض محتوى الرطوبة من(11.36٪ إلى 11.00٪) ، البروتين من (10.47٪ إلى 9.71٪) والكربوهيدرات من (72.14٪ إلى 69.66٪). كان هناك زيادة معنوية ($p < 0.05$)في الزنك (Z) والكالسيوم (Ca) والبوتاسيوم (K) والفوسفور (P) والحديد (Fe) من 1.30 إلى 1.63 مجم / 100 جم ، 45.90 إلى 281.45 مجم / 100 جم ، 172.08 إلى 41.25 ملجم / 100 جم ، 67.44 إلى 89.08 ملجم / 100 جم و 6.60 إلى 7.85 ملجم / 100 جم على التوالي . أظهرت نتائج الخواص الريولوجية ان اضافة مسحوق العاقول قد اثر سلبيا على بعض قيم الفارينوجراف والاكستنسوجراف كما أظهر التقييم الحسي أنه على الرغم من ان هناك تحسن فى القيمة الغذائية ، ولكن قابلية جميع عينات الخبز تحت الدراسة قد انحفضت بزيادة نسبة العاقول خاصة عينات خبز التوست 7.5، 10 ٪ ، بصفة عامة يمكن القول بأنه فى الاستطاعة انتاج منتجات مخبوزات مقبولة مثل خبز التوست باستخدم العاقول بنسبة 2.5 ،5 ٪ كما ان مسحوق العاقول يعتبر مصدرا غنيا للكالسيوم والفوسفور والحديد ويمكن ان يستخدم لاعداد العديد من منتجات المخابز ولكن هنالك حاجة الى تنفيذ المزيد من الدراسات لتقييم الاتاحة الحيوية لتلك العناصر المعدنية .

الكلمات المفتاحية: الخبز ،العاقول ، التقييم الحسي ، الخصائص الريولوجية ، التركيب الكيميائي