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UTILIZATION OF BARLEY MALT AS A PARTIAL REPLACEMENT OF WHEAT FLOUR IN BISCUITS INDUSTRIES

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ABSTRACT: The current study aimed to utilize hulled and naked barley malt as a substitute supplementation of wheat biscuits. Physicochemical properties of hulled and naked barley malt were studied. Wheat flour was substituted by 25, 30 and 35% of hulled and naked barley malt. The obtained results declared that the rheological characteristics of mixtures dough were altered by increasing the ratio of hulled and naked malt barley. Substitution with 25 and 30% hulled and naked barley malt had the best results which were relatively close to that of control sample. The physicochemical properties of biscuits enriched by hulled and naked barley malt that characterized by increasing both density, texture, water holding capacity and oil holding capacity. Chemical composition of enriched biscuits, for moisture, ash, dietary fiber, protein and minerals content were increased while fat and available carbohydrate content lowered. Sensory evaluation showed that substitution with 25% and 30% hulled and naked barley malt had the best sensory characteristics, and increased its content of dietary fiber and β-Glucan.

Key words: Barley malt, β-Glucan, biscuits, wheat flour.

INTRODUCTION

In the last decades the search for functional foods has been widely encouraged by food companies. Consumers demand of new food products not only to satisfy a physiological need but also to have healthy food with necessary nutrients to prevent nutrition-related diseases and to improve physical and mental health. In this regard, a close relation between nutrition and health has been established and functional foods containing ingredients with a specific health benefit were technologically developed as reported by **Niva (2007)**.

Barley (*Hordeum vulgare* L.) is an ancient and important cereal grain crop. According to **FAO (2014)**, the world production of barley is about 144.5 milion ton, with about 102.244 thousand ton annually Egyptian production. In recent years, about two-thirds of the barley crop production has been used for feed, one-third for malting and about 2% for food directly. However, throughout its history, it has remained a major food source for some cultures principally in Asia and Northern Africa (**Newman and Newman, 2006**). Barley was recognized early as a hearty tasting, high-energy food. For example, the Roman gladiators were known as ‘‘hordearii’’ or ‘‘barley men’’ relative to eating barley providing them strength and stamina. While in Middle Eastern and North African countries, barley is pearled, ground, and used in soups, flat bread making and porridge preparation (**Sullivan *et al.*, 2012**). Whole barley grain consists of about 65–68% starch, 10–17% protein, 4–9% β-glucan, 2–3% free lipids and 1.5–2.5% minerals (**Izydorczyk *et al.*, 2000 ; Quinde *et al.*, 2004**).

The major advantage of incorporating barley into various food products and the consumption of its stems is for thepotential health benefits. The effectiveness of barley β-glucans, and glycemic index in barley food products in lowering blood cholesterol was reported

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(**Meiselman, 2016**). Barley is a rich source of tocols, including tocopherols and tocotrienols, which are known for reducing serum low density lipoprotein cholesterol (LDL-C) through their antioxidant action (**Pins and Kaur, 2006**). The predominant food product of barley is malt which is mainly used in the brewing industry. Malt is the product resulted from controlled germination, drying and milling of barley. Barley malt was used as food ingredient for its wide range of attributes and benefits. It may be used as a flavouring agent or flavouring enhancer, source of nutrients and fermentable sugars and natural colouring agent or as a colour enhancer through browning reactions. Barley malt also find application in a wide range of health foods including crisp breads, biscuits, breads, breakfast cereals, confectionery, baby foods, milk drinks, pet foods, sauces, soups and seasonings (**Sullivan *et al.,* 2012**). The largest use was in fermented bakery products as a source of soluble sugars, protein and amylases to promote the activity of yeast resulting in good bread texture and higher loaf volume, good flavour and colour of the end baked products (**Mahdi *et al*., 2008**).

The aim of this study was to evaluate the physiochemical properties of naked and hulled barley malt, use it as wheat flour substitute with different levels (25%, 30% and 35%) in biscuits manufacturing and evaluate the effect of these substitution levels on the quality attributes of the end product (biscuit).

MATERIALS AND METHODS

Materials

Raw hulled and naked barley grains were obtained from Agriculture Research Center Giza, Egypt, while wheat flour 72% extraction, margarine, vanilla, sugar, skim milk powder, ammonium bicarbonate and baking powder were obtained from local market, Zagazig, Sharkia Governorate, Egypt. All chemicals used in this study were analytical grade and purchased from El-Gomhoria Co., Zagazig, Sharkia Governorate, Egypt.

Methods

Malt Preparation

The method described by Mareček *et al.* (2016) was used for malt preparation. Malt was obtained from controlled germination of barley grains, the germinated grains were subsequently dried at 45°C/72 hrs., and ground and sieved using a 2.5-mm sieve.

Biscuits Preparation

Biscuit samples (control and with different substitution levels) were prepared according to the standard recipe described in Table 1 except that in case of biscuits with malt addition, a partial replacement of wheat flour 72% with levels; of 25%, 30% and 35% of malt was performed. Sugar, fat and vanillin were creamed in mixing bowel for 15 min., ammonium bicarbonate and water were added and mixed for 2 min. Wheat flour (in case of control sample) and malt and substituted wheat flour (in case of biscuits with different substitution levels) were added to the mixture with skim milk powder and baking powder. The mixture was subsequently mixed until getting homogeneous dough. The later was removed from mixing bowl, laminated, sheeted and shaped by cutting machine. Baking was carried out at 250°C for 10 min. After baking biscuits were being cooled at room temperature and then warped tightly by aluminum foil and kept for sensory evaluation as reported by Mesías *et al.* (2015).

Assessments

Proximate chemical composition

The chemical composition of different biscuit samples; moisture, ash, crude protein, fiber, mineral and crude lipid contents (%) was determined according to the methods described by **AOAC (2005)**, while total carbohydrate content was calulated by difference. However, β-glucan content was determined according to method described by **AOAC (1995)** at the Central Laboratory, Faculty of Agriculture, Zagazig University, Zagazig, Sharkia Governorate, Egypt.

Physical properties of biscuit

Hardness Determination

The hardness (N) of different biscuit samples was determined at Food Technology Research Institute, Giza, Egypt, according to **Mesías *et al.* (2016)** using Texture Analyzer (Texture Technologies Corporation, USA) equipped with a 50 kg load cell, a probe (Warnere Bratzcer,

Table 1. The recipe used for biscuits making

Ingredient	Amount (g)						
	Standard wheat flour (72%)	Substituted wheat flour by malt powder					
		Hulled barley malt powder			Naked barley malt powder		
		25%	30%	35%	25%	30%	35%
Wheat flour	100	75	70	65	75	70	65
Malt powder	0	25	30	35	25	30	35
Margarine	24	24	24	24	24	24	24
Sugar	30	30	30	30	30	30	30
Vanilla	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ammonium bicarbonate	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Skim milk powder	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Baking powder	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Water	12.0	12.0	12.0	12.0	12.0	12.0	12.0

HDP/BSK knife model) with a compression speed of 1 mm. s^{-1} and a distance prolongation of 10 mm. The force at the first major drop in the forced formation curve (F_{max}) and deformation at maximum force were obtained for 4 replicates for each sample.

Density measurement

The density of different biscuit samples was determined using Archimedes (buoyancy) method according to Amiri *et al.* (2017). Was determined according to the following: Density = mass/volume (g/cm^{-3})

Colour measurement

The colour of biscuit crust r was measured according to Zenoozian *et al.* (2007) using a Minolta colorimeter (Model CR- 400, Konica Minolta Sensing, Inc., Osaka, Japan) based on three colour coordinates; L* (Lightness), a* (redness/ greenness), b* (yellowness/blueness). The measurement for each sample was replicated and the average value was recorded for each colour parameter.

Water Holding Capacity

Water Holding Capacity (WHC) was measured according to **Chau and Huang (2003)** with slight modification, one gram of wheat flour 72% and malt substituted wheat flour was well mixed with 20 ml distilled water and allowed to stand 1 hr., at room temperature. The hydrated sample was centrifuged at 1500 rpm for 10 min. After centrifugation, the excess supernatant was carefully decanted. WHC was expressed as ml of retained water by 1g dry basis of sample (ml.g).

Oil Holding Capacity

Oil Holding Capacity (OHC) was measured according to Garau *et al.* (2007) with slight modification. One gram of wheat flour 72% and malt substituted wheat flour was mixed with 20 ml corn oil and allowed to stand 1 hr., at room temperature; the sample was then centrifuged at 1500 rpm for 10 min. The excess oil was carefully decanted. WHC was expressed as ml of retained oil by 1g dry basis of sample (ml. g).

Rheological Behavior

Farinograph and extensograph of dough rheological properties were measured according to **AACC (2007)**.

Dough properties by farinograph

Water absorption (%), dough development (min), stability time (min) and dough weakening were determined by Brabender Farinograph (model 810114, Brabender, Duisburg, Germany) at Food Technology Research Institute Giza, Egypt.

Dough properties by extensograph

Dough extensibility E (mm), resistance to extension R (BU), Energy (cm^2) and proportional number R/E were determined by Brabender Extensograph (model 860702, Brabender, Duisburg, Germany), Food Technology Research Institute Giza, Egypt.

Sensory Evaluation

Sensory evaluation was performed as described by **Hooda and Jood (2005)**. Biscuit samples were presented as coded samples to ten member staff at food science department, Faculty of Agriculture, Zagazig University to evaluate the sensory attributes of the biscuits according to it's appearance, colour, taste, flavour and overall acceptability. The evaluation was based on hedonic scale of 1 to 9 point, where (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8, like very much, 9 = like extremely).

Statistical Analysis

The obtained data were statistically analyzed by a statistical for social science package "SPSS" version 20 for Microsoft windows, SPSSInc according to Dominick and Derrick (2001).

RESULTS AND DISCUSSION

Proximate Chemical Composition of Malt from Hulled and Naked Barley

Hulled and naked barley malt were analyzed for moisture, crude protein, crude fiber, crude fat, total carbohydrate, ash, and β-glucan contents and the results are given in Table 2. The obtained results, at extremely same level of moisture content in both types of malt. Protein, ash and total carbohydrate contents in hulled barley malt were higher than in naked barley malt. On the other hand, naked barley malt had higher content of crude fat and crude fiber.

β-glucan, the major fiber constituents of barley, have been implicated in lowering plasma cholesterol, improving lipid metabolism, and reducing glycaemic index (**Behall *et al.,* 2004, 2005 and 2006; Steelea *et al.,* 2013**).

A considerable amount of β-glucan was found in both types of malt. Malt of hulled barley contained slightly higher level than other malt. These results are in general agreement with results obtained by **Izydorczyk *et al.* (2000) and Quinde *et al.* (2004)**. They reported that whole barley grain consists of about 65–68% starch, 10–17% protein, 4–9% β-glucan, 2–3% free lipids and 1.5–2.5% ash.

Some of the minerals contents of malt were also shown in the same Table. The malt was analyzed for calcium, phosphorus, zinc, iron and selenium .The results declared that malt consider to be a good source for phosphorus, zinc, selenium, calcium and iron but lower in the other minerals as reported in **USDA (2004)**. Calcium is required for formation and maintenance of bones and teeth thus, preventing osteoporosis. It is also needed for normal blood clotting and nervous function, the calcium content in hulled barley malt was higher than in malt naked barley by 24.59%. The phosphorus content in hulled barley malt was higher than in naked barley malt by 13.54%.

Iron is another essential element for almost all living organisms (**Abbaspour *et al.,* 2014**), hulled barley malt had a double amount of iron that found in naked barley malt. Selenium content in hulled barley malt was higher than that found in naked barley malt, which contained 10.35 and 8.86 mg/100g, of this type, respectively.

Water and Oil Holding Capacity of Substituted wheat flour by malt

WHC and OHC of wheat flour 72% and substituted flour with malt from hulled and naked barley flour as well, was evaluated (Table 3). The obtained results showed that both WHC and OHC were increased, as general tendency, after the substitution. These properties were increased by increasing the level of malt addition regardless the barley variety; the high WHC and OHC were observed for wheat flour substitution by 35% as substitution level for the two barley varieties. WHC increased by 18% and 21%

Table 2. Proximate chemical composition of malt from Hulled and Naked barley on wet weight basis

Parameter	Hulled barley	Naked barley
Moisture (%)	9.7±0.16	9.7±0.12
Protein (%)	12.3±0.86	11.9±0.89
Ash (%)	2.37±0.04	1.63±0.05
Fat (%)	2.39±0.09	3.1±0.097
Fiber (%)	19.5±0.30	23.7±1.2
***Carbohydrate (%)**	53.74±2.34	49.97±1.181
β-glucan (%)	8.9±0.249	8.2±0.125
Calcium (mg/100g)	150.23	120.58
Phosphorus (mg/100g)	243.25	214.25
Zinc (mg/100g)	23.66	34.55
Iron (mg/100g)	7.87	3.67
Selenium (mg/100g)	10.35	8.86

* Carbohydrates percentage was calculated by the difference.

while, OHC was increased by 11% and 7% with 35% of wheat flour substitution by hulled and naked barley malt, respectively compared to wheat flour 72%. It is important to mention that the WHC of wheat flour substituted by naked barley malt was higher than those of wheat flour substituted by hulled barley malt. However, the OHC of the later was higher compared to that of wheat flour substituted by naked barley (Table 3). The increasing of WHC in substituted wheat flour compared to wheat flour 72% may related to the substitution of wheat flour by barley malt. However the high WHC of substituted wheat flour by naked barley malt may due to its high content of fiber (23.7%) compared to those of hulled barley malt. The high OHC of substituted wheat flour by hulled barley malt can explain by its low fat content allowing more absorption of oil compared to naked barley malt which had high fat content decreasing more absorption of oil. These results concerning WHC are in agreement with the results reported by **Izydorczyk *et al.* (2005)**.

Rheological properties

Farinograph indices

Farinograph measurements are summarized in Table 4. Results showed that the water absorption of dough was increased gradually from 57.4% of control to 59.4% and 62.5% at addition levels of 35% of hulled and naked barley malt, respectively. The obtained results showed that increasing the addition of malt of both types of barley more than 25% led to deleterious effect in dough characteristics. Farinogram indices like arrival time, development time and dough stability were lowered in 30 and 35%malt mixtures, so the degree of weakening effect (a degree of softening, the vertical space in BU between the end of farinogram after 12 min. of its peak and the 500 BU line) increased from 100 to reach 130 BU, at 35% naked barley.

Extensograph results

Results of extensograph parameters of wheat flour blended with 25, 30 and 35% hulled and

Table 3. Water and oil holding capacity of substituted wheat flour by hulled and naked barley malt with different levels

Property/ sample	Wheat flour (72%)	Substituted wheat flour					
		Hulled barley malt			Naked barley malt		
		25%	30%	35%	25%	30%	35%
WHC	180.9±1.90	186.2±.95	199.1±2.1	213.5±2.1	192.6±1.87	205.1±2.28	218.2±1.74
OHC	171.2±1.86	179.4±1.18	183.7±1.5	189.8±0.8	176.8±0.82	181.4±1.03	183.2±1.79

WHC: Water holding capacity OHC: oil holding capacity

Table 4. Effect of wheat flour substituting by hulled and naked barley malt with different levels on farinograph dough characteristics

Dough properties	Wheat flour (72%)	Substituted wheat flour					
		Hulled barley malt			Naked barley malt		
		25%	30%	35%	25%	30%	35%
Water absorption (%)	57.4	58.1	58.7	59.4	60.1	61.7	62.5
Arrival time (min)	1.5	1.0	1.0	1.0	1.0	1.0	0.5
Dough development time (min)	2.5	2.0	2.0	2.0	1.5	1.5	1.0
Stability time (min)	7.5	7.0	6.0	6.0	6.5	6.0	6.0
Degree of softening (BU)	100	100	120	125	100	120	130

naked barley malt were given in Table 5. Results showed that elasticity, resistance to extension (R), of dough containing up to 25% hulled and naked barley malt was increased from 420 BU for control to 450 and 390 BU, respectively. Increasing the malt added to the flour over that lowered the elasticity to about half of control. On the other hand, the addition of malt caused a gradual decrement in dough extensibility (E) with increasing the adding level of both types of malt.

The proportional number (R/E) is an overall index that indicates the effects of the treatments on the quality of dough. The results in Table 5 show that both types of malt and amount of malt affect the quality of dough. Addition of malt up to 25% in dough had an enhancer effect in dough quality while the higher concentrations from both types of malt showed defects in quality. Energy values of dough decreased by adding of either hulled or naked barley malt than the control sample.

The rheological results showed that the malt addition from both types of barley up to 25 and 30% have potentialities to be used in supplementing flour for manufacture biscuit. On the other hand, increasing the supplementation will have deleterious effects on dough quality. However, it is a well known that weak flours are suitable for manufacture biscuit. These results are in agreement with **Campos *et al.* (1997) and Skendi *et al.* (2009)**.

Quality Attributes of Biscuit Manufactured Using Substituted Wheat Flour by Barley Malt

Chemical composition and nutrition value

Chemical composition and nutrition value of biscuit manufactured using wheat flour 72% and substituted wheat flour by hulled and naked barley malt were determined. The obtained results show that moisture content of biscuit manufactured from substituted wheat flour by barley malt was higher than those manufactured from only wheat flour 72% under the same conditions of baking (Table 6). This phenomenon could be explained by the high fiber content found in barley malt regardless the barley type compared to wheat flour 72% allowing more

Table 5. Effect of wheat flour substituting by hulled and naked barley malt with different levels on extensograph dough characteristics

Dough property	Wheat flour (72%)	Substituted wheat flour					
		Hulled barley malt			Naked barley malt		
		25%	30%	35%	25%	30%	35%
Elasticity R (BU)	420	450	240	150	390	360	210
Extensibility (BU)	90	85	80	45	80	75	65
P.N*(R/E)	4.67	5.29	3.0	3.33	4.8	4.8	3.23
Energy (cm^2)	62	42	36	28	54	47	19

* P.N: Proportional number R/E:(elasticity/extensibility)

Table 6. Chemical and nutritional evaluation of biscuits supplemented by hulled and naked barley malt on wet weight basis

Parameter	Control	Hulled barley			Naked barley		
		25%	30%	35%	25%	30%	35%
Moisture (%)	8.1±0.27	8.3±0.414	8.5±0.68	8.8±0.49	8.4±0.39	8.9 ±0.5	9.2±0.58
Protein (%)	9.91±0.33	10.6±0.22	10.9±0.28	11.3±0.16	10.3±0.1	10.8±0.5	11.2±0.2
Fat (%)	26.9±0.47	26.3±0.31	25.1±0.51	24.3±0.41	26.6±0.2	25.5±0.2	24.9±0.1
Fiber (%)	0.89±0.061	3.14±0.15	3.59±0.16	4.04±0.123	3.77±0.06	4.34±0.2	5.02±0.2
Carbohydrate (%)	53.43±0.29	50.65±0.87	50.88±0.91	50.46±0.15	50.08±0.2	49.53±0.5	48.72±0.7
Ash (%)	0.77±0.01	1.01±0.01	1.03±0.21	1.1±0.01	0.85±0.01	0.93±0.01	0.96±0.01
Fe (mg/100g)	4.38	5.27	5.44	5.62	4.72	4.78	4.86
Zn (mg/100g)	3.40	3.42	3.43	3.44	3.45	3.46	3.47
Ca (mg/100g)	8.05	9.84	10.2	10.55	9.19	9.44	9.64
Energy (K.cal)	495.46	483.2	475.3	465.7	479.42	470.82	460.78

*Avalable carbohydrates percentage was calculated by the difference.

absorption and retention of water. It was found that the chemical composition of biscuit improved after the wheat flour substitution by hulled and naked malt. The increasing in the chemical component such as proteins, ash, fiber, minerals may due to the inherent content of barley malt used which contribute to these components content of the resulted biscuit. Results in the present study are in agreement with those reported by **Izydorczyk and Dexter (2008)**. The energy of biscuits decreased after wheat flour substitution by barley malt as general tendency regardless barley variety. Moreover, it decreased with increasing the substitution level. The decrease was more higher in case of wheat flour substituted by naked barley malt compared to hulled barley malt. It decreased by 6% and 7% at 35% as level of substitution, respectively compared to biscuit from wheat flour 72%. This may explain by the high fiber content in barley malt particularly from naked barley.

Physical properties

Density, hardness and colour of biscuits manufactured using wheat flour 72% and substituted wheat flour by hulled and naked barley malt were determined. The obtained results showed that biscuit density increased after wheat flour substituted by barley malt regardless the barley variety compared to those from wheat flour 72%; it increased with increasing the substitution level (Table 7). It increased by about 6% and 9% at 35% substitution level by hulled and naked barley malt, respectively compared to wheat flour 72%. This increasing in biscuit density may due to the variation of chemical composition between the wheat flour 72% and the blend (substituted wheat flour), mainly due to the high fiber content of blend. At level 25% of wheat flour substitution by hulled and naked malt, there were insignificant variation in biscuit density for all biscuit samples, a slight increasing of biscuit density was afterward observed; biscuit density of substituted wheat flour by naked barley malt was higher than those from substituted wheat flour from hulled barley malt. The high biscuit density from substituted wheat flour by naked barley malt could be explained by the high fiber content which found in naked barley malt (23.7%).

As biscuit hardness, it was found that biscuit hardness increased after wheat flour substitution by barley malt and with increasing the substitution level as well. The highest hardness was recorded for the highest substitution level (35%) regardless barley variety (Table 7). It increased by about 34% and 47% when wheat flour, substituted by hulled and naked barley malt, respectively compared to that from wheat flour 72%. Biscuit manufactured from substituted wheat flour by naked barley malt was harder than that manufactured from substituted wheat flour by hulled barley malt lowering its acceptability (Table 8). It may due to the high fiber content of naked barley malt (23.7%) versus (19.5%) in hulled barley malt. These results are in concordance with those obtained by Ames *et al.* (2006).

Food colour is one of the most important factors affecting consumer acceptance of end product. Concerning biscuit colour parameters; L*, a*, b*. It was found that the lightness of biscuits decrease after wheat flour substitution by barley malt, the decreasing was significant for the biscuit manufactured from substituted wheat flour by hulled malt barley especially at 25% substitution level. It was decreased by about 64% and 63%, respectively compared to that manufactured from wheat flour 72% and from substituted wheat flour by naked barley malt. This mean that there was insignificant variation in the lightness between biscuit manufactured from wheat flour 72% and that manufactured from substituted wheat flour by naked barley malt. Biscuit redness a* and yellowness b* increased after wheat flour substitution by barley malt with increasing substitution levels regardless the barley, but this increasing was remarkable in case naked barley malt substitution. The changes in colour parameters of biscuit manufactured using substituted wheat flour by barley may due to the variation of chemical composition compared to wheat flour 72%, the colour of malt itself and millard reaction which takes place during baking (Abd El-Hady *et al.,* 2011).

Sensory evaluation

Sensory evaluation was carried out to define the adequate level of wheat flour substitution by barley malt and to define which variety improved the whole quality of biscuit. The obtained results showed that biscuit manufactured from wheat flour 72% had the highest score for all sensory characteristics; appearance, colour, taste, flavour and all acceptability, followed by biscuit manufactured from substituted wheat flour at 25% of hulled and naked barley malt which was close to that manufactured from wheat flour 72%. The lowest score was recorded to the high level of substitution (35%) of barley malt particularly hulled barley malt. The sensory evaluation results confirmed the previous results indicating that 25% as substitution level was adequate level to substitute wheat flour by barley malt according to the physical properties.

Conclusion

In conclusion, hulled and naked barley malt have some of useful components based on its high content of very easily digested carbohydrates, enzymatically hydrolyzed protein, minerals, dietary fiber and healthy components made it suitable for enriching cereal products. Results from this study clearly showed that hulled and naked barley malt can be used up to 25 and 30% to enhance nutritional value of biscuits without remarkable effect on its rheological properties and quality parameters without any effects on the other organoleptic attributes.

Table 7. Physical properties of biscuit manufactured using wheat flour 72% and substituted wheat flour by hulled and naked barley malt

Physical property	Wheat flour (72%)	Biscuit					
		Hulled barley malt			Naked barley malt		
		25%	30%	35%	25%	30%	35%
Density (g. cm^{-3})	1.52	1.57	1.59	1.61	1.56	1.61	1.65
Hardness (N)	17.60	19.21	21.37	23.64	19.46	22.38	25.78
L*	52.61	49.7	48.88	47.2	51.72	50.96	50.66
a*	3.03	3.86	4.24	4.90	3.65	4.88	6.07
b*	17.97	18.46	19.47	21.44	20.41	20.95	20.7

L* (Lightness), a* (redness/greenness) and b* (yellowness/blueness).

Table 8. Sensory evaluation of biscuit manufactured using wheat flour 72% and substituted wheat flour by hulled and naked barley malt

	Appearance (10)	Colour (10)	Taste (10)	Flavour (10)	Over all acceptability
Control	9.13±0.805	9.2±0.748	9.13±0.80	9.2±0.541	9.41±0.489
Hulled Barley					
25%	8.13±1.024	8.1±1.24	8.33±1.14	8.67±0.869	9. 37±1.24
30%	8.02±1.22	8.21±1.22	8.06±0.771	8.18±0.881	8.51±0.956
35%	7.93±1.062	7.93±1.062	7.75±1.042	8.25±1.042	7.38±1.161
Naked Barley					
25%	8.2±1.661	8.2±1.661	8 ±1.316	8.13±1.087	9.12±1.087
30%	8.46±0.884	8.42±0.884	8.4±0.952	8.46±0.805	9.33±0.942
35%	8.33±1.33	8.06±1.34	8.1±1.181	7.93±0.997	8.6±1.963

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الاستفادة من مولت الشعير كبديل جزئى لدقيق القمح في صناعة البسكويت

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تهدف الدراسة الحالية إلى الاستفادة من مولت الشعير المغطى والعارى في تدعيم دقيق البسكويت وقد تضمنت هذه الدراسة تقدير الخواص الفيزيائية والكيمائية لمولت الشعير المغطي والعاري، ودقيق القمح مع ٢٥%، ٣٠% و٣٥% من مولت الشعير المغطي والعاري وأظهرت النتائج التي تم الحصول عليها أن الخصائص الريولوجية تغيرت بزيادة نسب الأستبدال مع مولت الشعير المغطي والعاري، كما أعطي الإستبدال مع ٢٥% و ٣٠% من مولت الشعير المغطي والعاري أفضل نتائج وكانت قريبة جدا من عينة الكنترول، وقد اتسمت الخصائص الفيزيائية والكيمائية للبسكويت المدعم بمولت الشعير المغطي والعاري بزيادة الكثافة والصلابة والقدرة على الأحتفاظ بالماء والزيت أما بالنسبة للتركيب الكيميائي فقد زادت الرطوبة، الرماد، الألياف الغذائية، البروتين والمعادن وانخفض المحتوي من الكربوهيدرات والدهون، ولقد أوضحت نتائج التقييم الحسى أن البسكويت المدعم ب٢٥% و٣٠% اعطي أفضل نتائج حسية، كما أظهرت النتائج أن تدعيم البسكويت بمولت الشعير المغطي والعاري يزيد من محتواة من الألياف الغذائية والبيا جلوكان.

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