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Production of Novel healthy Barely Flakes by using Naked Barley, Naked Oats and Unused Baladi bread (Sahla)

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ABSTRACT

Healthy food became a modern necessity for what it represents of the utmost importance in human life due to the progress and speed of lifestyle. The present study relied on preparing healthy breakfast flakes in three blends. The first blend was prepared by using naked barley mixed with defatted coconut powder (T1 and T4), the second blend was naked barley mixed with naked oats and defatted coconut powder (T2 and T5), the third blend was naked barley mixed with unused baladi bread (sahla) and defatted coconut powder was (T3 and T6), also, a yellow color of (turmeric) was added. Two control samples were prepared (C1 and C2) from corn and two methods were used in cooking (extrusion and baking using oven). The proximate analysis, mineral contents, dietary fiber, antioxidants, color index and sensory evaluation were done for produced flakes. The results of proximate analysis for flakes blends showed that the barley flakes were high in protein, fat, dietary fiber, ash, and low in total carbohydrates and energy compared with control sample made from corn, while control samples (1 & 2) were low in all such parameters. Dietary fiber, soluble fiber, insoluble fiber, *β–glucan*, and antioxidants (flavonoids and phenols) showed a double amount in different samples of prepared barley flakes. Functional components such as *β–glucan* and antioxidants in barley flake blends, *β–glucan* were higher in T1, T2, T4 and T5. The control samples were free of *β–glucan* and antioxidants. The physical properties of the control and barley flakes were studied. Also, specific volume for barley flakes samples compared to the control decreased. The observed color index of barley flakes samples and the control were slightly decreased in color degree barley flakes samples. Sensory evaluation showed a slightly decrease between barley flakes and control samples (1 and 2) but good and acceptable in general properties.

1. Introduction

Dietary recommendations state that breakfast cereals are a significant source of vital nutrients due to their high nutrient density, especially those that are whole grain or high in cereal fiber (National Health and Medical Research Council,2013). According to research, consuming ß -glucan can increase postprandial satiety, lower body weight, BMI, and total calorie intake (Aoe et al., 2014). Excellent sources of both soluble and insoluble dietary fiber as well as other bioactive substances are barley and oats dehulled barley and oats have dietary fiber contents that range from 10 to 28% (Messia et al., 2017). *β–glucan* , phytochemicals, and antioxidant potential, whole grain crops like barley (Hordeum vulgare), rye (Secale Cereale), and oat (Avena sativa) were considered to be functional grains (Sharma and Gujral, 2010).

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Barley is characterized by its high grain *β-glucan* content, almost 10-fold higher than wheat on average (Geng et al., 2022). Barley flour is also used in foods such as muffins, biscuits, unleavened flatbreads, noodles and other bakery and no-bakery products (Newman and Newman ,1991). In Egypt, barley is typically grown on an average of 87752 hectares each year, yielding 117113 tones annually (FAO, 2010).

One of the healthiest grain cereals, oats is rich in fiber and protein. Oats have recently been incorporated into many functional foods due to their nutritional benefits, which have drawn the attention of researchers from around the world and increased the food industry's interest in using oats as a food ingredient in a variety of food products, such as bread, (Fraś, et al., 2018), breakfast cereals, (Decker et al., 2014). One of the main elements of soluble fiber in oat is *β–glucan* (OBG), oat grains, which are high in *β–glucan* could be added to the diet to help prevent conditions including type II diabetes, obesity, and several cancer. Oats contain numerous important amino acids that are required by the human body (isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, threonine, tryptophan, and valine (Youssef et al., 2016). Indeed, it is well documented that diets rich in *β-glucan* can improve the immunity of human bodies, providing protection against hypertension, stroke, cardiovascular disease, and type 2 diabetes (Tosh and Bordenave, 2020).

The majority of bakery waste is unused bread that has been taken from the market because they are no longer marketable after just 24 hours, but it can also include other ingredients like dough, wheat, sugar, and other edible elements like icing, burnt, or unused products (McGregor, 2000). Losses on bakery products amount to about 10 million tons worldwide (Demirci et al., 2016). If just one-fourth of the food currently lost or wasted globally could be saved, it would be enough to feed hungry people in the world (FAO, 2013). In Egypt, survey results of bread and bakery waste showed that 16.5% of the respondents waste more than 6% of purchased cereals and bakery products (Capone et al., 2016). Due to the necessity to transform industrial waste products into useful components for food formulations Coconut residue produced during the wet processing of coconut to extract the milk or the dry processing of coconut to extract the oil is used to make coconut flour. Coconut flour was highlighted by Trinidad et al., (2006) as a valuable source of dietary fiber and revenue. Coconut flour is not only high in dietary fiber but also low in carbs, trans fats, and cholesterol. Because coconut flour is gluten-free, people with celiac disease can use it, (Adeloye et al., 2020).

Food extrusion is a new technique that allows the food industry to prepare and distribute a wide range of goods with variable sizes, shapes, textures, and tastes. Extrusion cooking technology has enabled the creation of a wide range of goods, including pasta, breakfast cereals, bread crumbs, biscuits, crackers, croutons, chewing gum, confectionary items and dried soups. The functional qualities of extruded food, such as water absorption, water solubility, oil absorption indexes, expansion index, bulk density, and dough viscosity, are crucial for consumer acceptance. (Alam et al., 2015).

The aim of our study was to use Naked Barley, Naked Oats and Unused Baladi bread (Sahla) for producing healthy breakfast flakes in three blends. The three blends were prepared by using naked barley mixed with defatted coconut powder (T1 and T4), naked barley mixed with naked oats and defatted coconut powder (T2 and T5) and naked barley mixed with unused baladi bread (sahla) and defatted coconut powder (T3 and T6).

2. Material and Methods:

Naked barley grains, naked oats grains and corn grains were obtained from Field Crops Research Institute – Agriculture Research Center – Egypt. Defatted coconut flour, salt, baking powder, vanillin and corn oil were procured from the local market, Cairo- Egypt. Whereas Unused Egyptian flatbread was obtained from Cairo province - Egypt. All chemicals were used obtained from El-Gomhoria- Co, for Chemicals - Cairo Egypt.

Preparation of different materials

Grains are inspected and hand-cleaned to remove weeds and cleaned from foreign substances, and foreign particles. The cleaned samples were tempered and milled of bare barley and oat grains at (a nearby mill) that produced entire barley flour and oats with a 100% extraction rate. Using a lab hammer mill, the material was crushed into flour and sent through a sieve with a screen size of 60 (250 m particle size). Egyptian unused baladi bread was chopped, dried at 60°C for 6 hours and milled using the same techniques, flours were blended according to suggested formulae, and they were baked using one of two procedures (oven air or extrusion).

Formulation and cooking methods for the Flakes (Table 1.)

First method: by extrusion according to (Košutić et al., 2016). In order to achieve correct moisture distribution to a level of 25%, flours were thoroughly combined, conditioned (a hydrothermal treatment) for 12 hours, and then sprayed with a calculated amount of water.

Extrusion was carried out using a temperature-controlled barrel with four independent compression metering zones on a laboratory-scale Kompakt extruder KE 19 (single screw extruder) from Brabender, Duisburg, US.

These zones were kept at 100°C in temperature. The feed rate for each formulation was 10 kg/h, and the screw speed was 502 rpm and the pressure was 2 bar. The length-to-breadth ratio for the extruder was 1:1 and the dough was 1×1cm long, 1cm wide, and 2 mm thick. The prepared samples of extruded and supported flakes were gathered, dried, and cooled at room temperature, then packed in airtight bags for further investigation.

Second method: cooking by using steaming & oven air (Sundberg et al., 1994). In the first step, the mixture of flour according to the formulations showed in Table 1. mixed with hot water at 100°C added up to 30 % then steamed manually for 15min then defatted coconut flour, salt, and vanillin were added to the mixture and mixing continued, baking powder and corn oil were added. The dough was flattened 2 mm and cut in 1×1 cm, then baked at 180°C for along ±3 min. then cooling to room temperature and packed in polyethylene packages.

Table 1. Barley flakes formulation and cooking methods

Ingredients (g/100g)	Cooking by Extrusion				Cooking by oven air			
	Control C1	Flakes sample (T1)	Flakes sample (T2)	Flakes sample (T3)	Control C2	Flakes sample (T4)	Flakes sample (T5)	Flakes sample (T6)
Corn flour	97.3	--		--	92	--		--
Naked barley flour	-	92	60	60	-	92	60	60
Naked oats flour			32	--	--	--	32	--
Unused Egyptian baladi bread mill	--	--	--	32	--	--	--	32
Coconut flour	-	5.3	5.3	5.3	5	5	5	5
Vegetable oil	2	2	2	2	2	2	2	2
Vanillin	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Backing powder	--	--	--	--	0.3	0.3	0.3	0.3
Salt	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Tumeric (ppm)	--	15	15	15	15	15	15	15
Water	Condition to 25%				30%			

Proximate analyses

Proximate analyses were made according to the approach outlined in (AOAC, 2010), crude protein (official method number 950.36), ash (official method no 930.22), crude fiber (official method no 950.37), and crude ether extract contents (official method no 935.38) were computed. Carbohydrates were calculated by the difference between the total amount of crude protein, ash, and ether extract and the number of minerals was calculated in accordance with AOAC (2010). Using the Atwater formula, the energy value (on a dry weight basis) was determined as follows: energy (kcal/100 g)=4 % protein, 9 % fat, and 4 % carbohydrate. The estimated energy value was determined using (James 1995).

Energy (calculation method)

$$\text{Total calories (Kcal)} = \text{Fat} \times 9 + \text{Protein} \times 4 + \text{Carbohydrates} \times 4 \qquad (1)$$

Determination of total dietary fiber, Soluble dietary fiber and *β–glucan*

The total dietary fiber (TDF) and Soluble dietary fiber (SDF) content were determined in raw material and barley flakes samples .according to AOAC (2010), method no 32-07.01) could be obtained after ethanol precipitation, filtration, and drying. Duplicate samples are always processed which enables subtraction of protein and ash for TDF content calculation, Soluble dietary fiber (SDF) was calculated through the same procedure without using ethanol precipitation, where after filtration the content of insoluble, *β–glucan* content of barley and oats—rapid Enzymatic Procedure, according to AOAC (2010), method no. (32-23.01)

Determination of total phenolic content

Using the Folin-Ciocateu reagent method, to calculate total phenolic content (McDonald et al., 2001). Taking 0.5 ml of the extract, adding 0.1 ml of the Folin-Ciocateu reagent (0.5 N), waiting 15 minutes at room temperature and incubated again after adding 2.5 ml of saturated sodium carbonate for 30 minutes at room temperature and the extract samples were measured at 760 nm.

Determination of total flavonoids content

The aluminum chloride technique was used to determine the total flavonoid content (Chang et al., 2002). 1.0 ml of extract was taken, and 0.5 ml each of 1.2% aluminum chloride and 0.5 ml of 120 mm potassium acetate were added. The mixture was then incubated at room temperature for 30 minutes. Each sample's the extract samples was measured at 415 nm.

Determination of Color

The brightness, redness, and yellowness of the samples are all determined by measuring the color of the blended barley flakes using the CIE (*L*a* and b**) values, respectively. With a colorimeter (Konica Minolta Chroma Meter CR-400, Japan), each sample was individually measured in three copies. The calculations done to determine the change in color were made using the approach provided by Budžaki, et al. (2014).

Water absorption index (WAI)

After the extrusion procedure, the water absorption index (WAI) was determined, by measuring of the weight of gel obtained per gram of powdered dry sample. In the modified method of Kadan et al., (2003) Using a vortex shaker, 2 g of sample was combined with 20 ml of distilled water in a pre-weighed centrifuge tube for 5 minutes. This was followed by a 10-minute heating treatment at 85 °C in a water bath. Samples were centrifuged for 15 minutes at 3500 rpm after being cooled to ambient temperature. After gathering supernatant on Petri plates that had already been weighed, the residue was weighed. WAI was determined as follows:

$$\text{WAI} = \frac{Weight\ of\ residue}{Weight\ of\ dry\ solids} \qquad (2)$$

Oil absorption index (OAI)

With a few minor adjustments, the samples' oil absorption indexes (OAI) were assessed using the technique described by (Femenia et al., 1997). 1 g of the sample was combined with 10 mL of vegetable oil in a falcon tube, gently mixed for 5 minutes, allowed to stand at room temperature for 30 minutes, then centrifuged at 3500 rpm for 15 minutes while removing the extra oil. After re-weighing the sample with the absorbed oil, OAI was calculated as g oil/g dry weight (DW).

Water solubility index (WSI)

The water solubility index (WSI) was determined by evaporating the supernatant from the WAI samples (Kadan *et al*., 2003). The WSI of samples was calculated as the percentage of dry matter recovered after the supernatant has completely evaporated.

Specific Volume (SV)

Specific Volume was calculated as equal, SV (cm^3/g) = v /g. weight (g) and volume (cm3) of barley flakes blends made from naked barley flour was measured according to standard methods AACC (2010).

Bulk Density

Bulk density was measured by dividing baker Volume mass / by 1000 grains weight. Volume mass for corn flakes and barely flakes samples were analyzed using a 1L baker with marks and scale ACCU-LAB L-Series. 1L baker has put no scale, tarred and the extruded sample was poured in till its mark. Mass was recorded in three repetitions and the average was calculated (Liene and Sandra, 2016).

Sensory evaluation of extruded and baked flakes

According to Košutić et al., (2016) and Al Subhi (2014), ten panelists conducted a sensory evaluation of the corn flakes and barley flakes products at the Food Technology Research Institute, Bread and Pastry Dept., to ascertain the variation of the tested attributes (taste (9), odor (9), texture (9), color (9), appearance (9) and overall acceptability (9)) of corn flakes and barley flakes. The panelists received barley flaxes and cornflakes on a white dish at room temperature.

Statistical analysis

The explanatory data was examined using the SPSS 16.0 software. Expressive insights were used to resolve means and standard deviations. ANOVA's analysis of single direction fluctuation and multiple range tests were used to resolve comparisons between samples. Statistical significance was set at P> 0.05 (SPSS, 2000).

3. Results and Discussions

Chemical composition of raw materials

The results of proximate compositions of raw material, corn flour, naked barley flour, naked oats flour, unused Egyptian bread and defatted coconut powder are presented in Table. 2. The value of corn flour was recorded as 10.47% crude protein,2.1% ether extract, 2.1%ash, 6.8% dietary fiber, 4.93 Insoluble fiber, 1.87 % soluble fiber and 0.0 % β–glucans. These agree with Khalil *et al.,*(2018). Naked barley flour results recorded 12.62% crude protein, 2.85% ether extract, 1.80%ash, 15.65% dietary fiber, 10.4% Insoluble fiber, 5.25 % soluble fiber and 4.8% β–glucans. The data obtained were in agreement with (Šterna et al., 2017). Naked oats flour results recorded 13.23% protein, 7.94% fat, 2.0%ash, 16.58% dietary fiber, 10.36% Insoluble fiber, 6.2 % soluble fiber and 5.12 % β–glucans. These results were in agreement with Youssef, et al., (2016) and Renáta *et al.,* (2021). Main while, defatted coconut powder, results showed that it contains 21.95 % crude protein, 7.5 % crude,5.7fat%ash, 30.44% dietary fiber, 17.65% Insoluble fiber, 12.79% soluble fiber and 0.00 % β–glucans. In general, the results obtained were higher than those obtained by Gunathilake *et al*., (2009), who reported those defatted coconut powder had 21.95% proteins, 7.50% fat, 5.71% ash, dietary fiber 30.44%, insoluble fiber 17.65%, soluble dietary fiber 12.79%. Unused Egyptian baladi bread protein was 10.55%. So, the results reveal that naked oats flour, unused baladi bread and defatted coconut powder is a good sources of protein, ash and crude fiber. These results make them very useful to prepare high nutritional value bakery products.

Mineral contents of corn flour, naked barley flour, naked oats flour, unused baladi bread and defatted coconut powders mg ⁄100 g sample. The data showed that the mean value of minerals contents of (Ca, Fe, and Zn), Ca in defatted coconut powder (112.0 mg/100 g) which was higher than that in naked oats (60.9 mg/100 g) and naked barley (26.7 mg⁄100g) followed by (21.3 mg⁄100g) in unused baladi bread, while corn was the lowest one

(20. 12mg ⁄100 g). The content Fe in naked oats flour (3.81 mg ⁄100 g) is higher than that in defatted coconut powder (3.0 mg/100g) then naked barley (2.28 mg/100g)) followed by (2.12mg ⁄100 g) in corn while unused baladi bread was the lowest one (1.37mg ⁄100 g). The higher content of Zn was found in naked oats3.72 mg ⁄100 g is higher than that in naked barley (2.31mg/100g) then corn flour (2.10mg/100g)) followed by unused baladi bread (1.5 mg⁄100 g), while defatted coconut powder was the lowest one (0.09 mg ⁄100g). The results indicated that the tested materials are good sources for the minerals. These results agree with those reported by (Sangwan et al., (2014) as shown in Table 2.

Table 2. Proximate analysis of the raw material

Ingredient	Crude protein (%) crude	Fat (%)	Ash (%)	Diary fiber (%)	Insoluble fiber (%)	Soluble dietary fiber, (%)	β–glucan	Carbs	Mineral (mg/100gm)		
									Ca	Fe	Zn
Corn flour	10.47 ±0.15	2.1 ±0.08	2.1 ±0.06	6.80 ±0.12	4.93 ±0.14	1.87 ±0.08	NF ±0.00	80.4	20.12± 0.08	2.12 ±0.05	2.10 ±0.09
Naked barley flour	12.62 ± 0.17	2.85 ±0.05	1.80 ±0.13	15.65 ±0.19	10.40 ±0.11	5.25 ±0.11	4.8 ±0.06	72.33	26.73 ±0.09	2.28 ±0.03	2.31 ±0.07
Naked oats flour	13.23 ± 0.15	7.94 ±0.09	2.0 ±0.12	16.58 ±0.19	10.36 ±0. 17	6.2 ±0.18	5.12 ±0.16	66.77	60.90 ±0.10	3.81 ±0.07	3.72 ±0.03
Unused Egyptian baladi bread mill	10.55 ±0.11	1.12 ±0.04	1.53 ±0.05	5.52 ±0.17	3.33 ±0.15	2.19 ±0.09	NF ±0.00	83.47	21.34 ±0.04	1.37 ±0.09	1.5 ±0.05
Defatted coconut flour	21.95 ±0.32	7.50 ±0.09	5.71 ±0.09	30.44 ±0.31	17.65 ±0.21	12.79 ±0.15	NF ±0.00	47.19	112.00 ±0.07	3.00 ±0.09	0.09 ±0.07

Carbohydrate =100-(fat+protein+ash+insolouble dietary fibers), NF means not found

Proximate analysis of the extruded and baked barley flakes

The results in Table (3) represented the proximate analysis of all the baked or extruded barley Flakes samples. The data showed that the protein content of the Flakes treatments were (11–13%) and (9.32-9.33 g/100g) in C1andC2 while the highest protein content was observed in T2 and T5 which were made from naked barley flour and naked oat flour followed by T1and T4 which made from naked barley flour. Main while T3 and T6 which are made from naked barley flour and unused baladi bread had the lower protein which was found in C1 and C2. This result may be returned due to the higher protein contained in, naked barley flour, naked oats flour and defatted coconut powder compared with corn flour and unused baladi bread. The lowest significant difference in fat content was observed in C1 and C2 (4.04 and 4.00 g/100g), However fat content in flakes samples was increased significantly compared with naked barley flour, naked oats flour, unused Egyptian bread and defatted coconut powder ranged from (4.5 to 6.62 g/100g). Ash showed similar content in all flake samples and control ranged from (1.91- 2.13 g/100g). The content of crude fibers in flakes samples was increased in the significant ratio (8.2- 10.47%) while it (was 3.93and 3.94g/100g) in C1 and C2 respectively, the highest crude fiber content was found in T1 and T4 which made from naked barley flour followed by T2 and T5 which made from naked barley flour and naked oats flour then T3 and T6 which made from naked barley flour and unused baladi bread. This may be due to the higher dietary fiber contained in naked barley flour and naked oats flour bread compared with corn flour and unused baladi bread. drates and Energy were decreased significantly by using naked barley flour, naked oat flour and unused baladi bread compared with corn flour, and unused baladi bread.

Carbohydrates and Energy were decreased significantly by using naked barley flour, naked oat flour and unused baladi bread compared with corn flour, carbohydrate and Energy in C1 and C2 were (80.08% and 396.84 kcal/100g) and (80.33 and 396.64 kcal) respectively while the ranges were in flakes samples (67.08- 74.33% and 375.16-382.78 kcal) respectively. In many previous types of research, it was observed that the addition of naked barley flour and naked oats flour in Flakes led to an increase in protein, ash and dietary fiber. Youssef, et al., *(2016*) reported that oat flour is a good source of protein, fiber and ash compared with wheat flour. As for minerals, calcium was increased in T2 and T5 which made from naked barley and naked oats (47.00-46.74mg/100gm), then T1 and T4 (30.5-29.90mg/100gm) made from naked barley followed by T3 and T6 (28.7-28.41mg/100gm) made from naked barley and unused baladi bread. While control (C1 and C2) were the lowest calcium content (19.18- 19.16mg/100gm) respectively. Also, iron and zinc content was higher in samples made from naked barley and naked oats than in samples made from naked barley only flowed by samples made from naked barley and unused baladi bread, but control (C1 and C2) were the lowest calcium content. These results may be due to the high content of minerals in naked barley, naked oats, defatted coconut flour and unused baladi bread compared with corn flour. The data showed that producing of flakes from naked barley with defatted coconut powder or mixture from naked barley with naked oats and defatted coconut powder or mixture from naked barley with unused baladi bread and defatted coconut led to improve in chemical composition compared with corn flakes made from corn only.

Table 3. Proximate analysis of the extruded and baked barley flakes

Treatment g/100g	Crude protein	Total fat	Total ash	Crud fiber	TC	Energy (kcal)	Mineral (mg/100gm)		
							Calcium	Fe	Zn
(C1)	9.32^{c} ±0.10	4.04^{b} ±0.10	1.91^{a} ±0.08	3.93^{c} ±0.09	80.08^{a} ±0.32	393.96^{a} ±0.15	19.18^{c} ±0.19	1.91^{b} ±0.10	1.91^{b} ±0.17
(T1)	12.33^{a} ±0.16	5.00^{a} ±0.13	2.0^{a} ±0.06	10.46^{a} ±0.12	70.21^{c} ±0.25	375.16^{c} ±0.19	30.5^{b} ±0.17	2.31^{a} ±0.11	2.12^{a} ±0.11
(T2)	13.00^{a} ±0.19	6.61^{a} ±0.17	2.12^{a} ±0.09	10.45^{a} ±0.15	67.82^{c} ±0.27	382.77^{b} ±0.25	47.00^{a} ±0.18	2.73^{a} ±0.10	2.53^{a} ±0.16
(T3)	11.00^{b} ±0.15	4.5^{b} ±0.09	1.97^{a} ±0.11	8.20^{b} ±0.11	74.33^{b} ±0.31	381.82^{b} ±0.23	28.7^{b} ±0.12	1.9^{b} ±0.18	1.96^{b} ±0.19
(C2)	9.33^{c} ±0.11	4.00^{b} ±0.12	1.90^{a} ±0.15	3.94^{c} ±0.07	80.83^{a} ±0.30	396.64^{a} ±0.19	19.16^{c} ±0.15	1.90^{b} ±0.16	1.86^{b} ±0.12
(T4)	12.32^{a} ±0.17	5.05^{a} ±0.10	2.0^{a} ±0.12	10.47^{a} ±0.12	70.16^{c} ±0.27	375.37^{c} ±0.25	29.90^{b} ±0.16	1.24^{b} ±0.11	2.10^{a} ±0.18
(T5)	13.00^{a} ±0.19	6.62^{a} ±0.12	2.13^{a} ±0.17	10.45^{a} ±0.15	67.08^{c} ±0.23	382.78^{b} ±0.24	46.7^{a} ±0.17	2.64^{a} ±0.19	2.51^{a} ±0.13
(T6)	11.05^{b} ±0.12	4.51^{b} ±0.11	1.93^{a} ±0.10	8.21^{b} ±0.13	74.30^{b} ±0.27	382.99^{b} ±0.23	28.41^{b} ±0.14	1.78^{b} ±0.13	1.90^{b} ±0.10

C1= Control (1) , C2= Control (2). TC=total carbohydrates .
Values are expressed as mean ± SD, Means within a column showing the same letters are not significantly different (P≥ 0.05).

Functional components of the extruded and baked barley flakes

The functional components of the baked and extruded barley flakes were recorded in Table 4. The naked barley only or mixed with oats and unused baladi bread in flakes samples led to a higher significant difference and doubled contain in total dietary fiber, insoluble dietary fiber and Soluble dietary fiber compared with control C1 and C2 samples made from corn flour. Total dietary fiber ranges from (12.64 to 16.26 g100g) in barley flakes samples and (6.27 and 6.28 g/100g) in C1 and C2. Soluble dietary fiber was (4.43- 5.81 g100g) in barley flakes samples and (2.34 g/100g) in C1 and C2.

As well as, *β–glucan* content, was higher significantly in Barley only or mixtures with oats and unused baladi bread in flakes samples ranging from (4.4 to 4.53 g/100g) in flakes samples T1, T2, T4 and T5 which contain barley only or mixtures with oats,(4.40, 4.51,4.41 and 4.53 g/100g) in T3 and T6 which contain naked barley mixtures with unused baladi bread it was (2.91, 2.92 g100g) while C1 and C2 were free from *β–glucan*. This may be due to, total dietary fiber, insoluble fiber and soluble dietary fiber and *β–glucan* in naked barley and naked oats according to data presented in table (2). While dietary fiber and *β–glucan* were low or free in unused baladi bread and corn flour according to data presented in table (2) same results were reported by (Kumari et al., (2018) and Youssef, et al., 2016). Barley flakes samples were higher in total phenolic content ranges from (208.64 to 264.40 mg/100g) flakes samples, the lowest values were found in C1 and C2 (51.57 to 52.57 mg/100g). Results showed that the total flavonoid content was the same trend mg these results agree with Kumari et al., (2018), who claimed that as the proportion of barley flour in the extruded sample blends increases, the content of TPC and TFC in extruded snacks somewhat rises. This was most likely caused by the barley's high TPC and TFC content.

Table 4. Functional components of the extruded and baked barley flakes

Treatments	Total dietary fiber g/100g	Insoluble dietary fiber g/100g	Soluble dietary fiber, g/100g	β–glucanss, g/100g	Total phenolic content mg GAE/100 g)	Total flavonoid content mg GAE/100 g)
(C1)	6.27^{c}±0.16	3.93^{c}±0.09	2.34^{c}±0.06	nd	51.57^{c}±0.31	5.34^{c}±0.17
(T1)	15.90^{a}±0.15	10.46^{a}±0.12	5.44^{a}±0.09	4.40^{a}±0.12	251.81^{a}±0.33	72.63^{a}±0.19
(T2)	16.25^{a}±0.17	10.45^{a}±0.15	5.80^{a}±0.11	4.51^{a}±0.07	263.16^{a}±0.31	76.43^{a}±0.21
(T3)	12.65^{b}±0.18	8.20^{b}±0.11	4.45^{b}±0.14	2.91^{b}±0.11	208.64^{b}±0.27	51.37^{b}±0.18
(C2)	6.28^{c}±0.19	3.94^{c}±0.07	2.34^{c}±0.07	nd	52.57^{c}±0.29	5.56^{c}±0.15
(T4)	15.94^{a}±0.19	10.47^{a}±0.12	5.74^{a}±0.09	4.41^{a}±0.05	259.18^{a}±0.30	78.31^{a}±0.22
(T5)	16.26^{a}±0.11	10.45^{a}±0.15	5.81^{a}±0.08	4.53^{a}±0.09	264.40^{a}±0.27	81.43^{a}±0.20
(T6)	12.64^{b}±0.17	8.21^{b}±0.13	4.43^{b}±0.11	2.92^{b}±0.13	216.67^{b}±0.29	56.71^{b}±0.19

C1= Control (1), C2= Control (2) Values are expressed as mean ± SD,
Means within a column showing the same letters are not significantly different (P≥ 0.05).

Physico-chemical properties of the extruded and baked barley flakes

The data recorded in Table 5. showed that the final product of the barley flakes made from incorporating naked barley with defatted coconut powder or mixture from naked barley with naked oats and defatted coconut powder or mixture from naked barley with unused baladi bread and defatted coconut was analyzed for their physical properties such as moisture, water absorption index (WAI), water solubility index (WSI) oil absorption index (OAI), water activity (a_w), specific volume SV (cm³)/(g) and bulk density (g/ml). The moisture content was decreased and adjusted between 7.0–9.60% in flakes blends and (6.90-8.10 %) in C1, and C2 and there is a difference in static analysis between control and samples this may be due to the higher content of dietary fiber in barley, oats and defatted coconut which increase moisture content compared with corn and unused baladi bread, while the differences among flakes samples may be due to the different cooking methods oven air baking or extrusion cooking. WAI was decreased in barley flakes samples, ranging from 2.11 to 2.87 g and 3.20 to 3.00 g in C1 and C2 respectively. Table. 5, was observed that the WSI of barley flakes samples was decreased with add of barley, oats and defatted coconut ranging from 9.51 to 10.26 (%) and 11.31 to 10.87% in C1 and C2, respectively. The results were in agreement with, Kumari et al., (2018), who found that WAI, WSI, OAI, and water activity were decreased with increasing of barley content in samples. OAI showed no significant differences among barley samples and control ranges from 0.89 to 1.0g/g. The same Table showed that the specific volume was decreased in flakes samples ranging from 1.68 to 2.3 and 0.5043-0.60 in C1 and C2, respectively. This might be due to the high protein and dietary fiber content in barley flake blends according to Abdelazim et al., (2019), who reported a decrease in diameter and specific volume, as barley % and protein content was increased in biscuits samples. While, bulk density was increased in flakes samples ranging from 0.40 to 0.49 and 2.50-2.05 g/ml, in C1 and C2 respectively with a significant difference in static analysis between control and samples, this may be due to the decreased flakes samples volume to flakes samples weight.

Table 5. Physico-chemical properties of the extruded and baked barley flakes

Treatment	Moisture %	Water activity (a_w)	WAI (g/g)	WSI (%)	OAI (g/g)	SV (cm^3)/(g)	Bulk density (g/ml)
(C1)	6.90^c±0.14	0.57^a±0.04	3.20^a±0.11	11.31^a±0.26	0.91^a±0.17	2.5^a±0.13	0.40^d±0.08
(T1)	7.12^b±0.21	0.50^b±0.06	2.65^b±0.08	9.94^b±0.26	1.00^a±0.19	2.04^b±0.11	0.48^c±0.05
(T2)	7.26^b±0.16	0.50^b±0.07	2.50^b±0.14	9.89^b±0.26	1.00^a±0.17	1.91^c±0.19	0.52^b±0.09
(T3)	7.00^b±0.19	0.53^a±0.03	2.87^a±0.16	10.26^a±0.26	0.90^a±0.16	2.3^a±0.14	0.43^c±0.10
(C2)	8.10^b±0.15	0.58^a±0.07	3.00^a±0.10	10.87^a±0.26	0.91^a±0.18	2.05^b±0.12	0.49^b±0.07
(T4)	9.55^a±0.17	0.54^a±0.26	2.28^c±0.07	9.63^b±0.26	0.90^a±0.18	1.81^c±0.26	0.55^a±0.05
(T5)	9.60^a±0.20	0.54^a±0.26	2.11^c±0.13	9.51^b±0.26	0.91^a±0.15	1.68^c±0.26	0.60^a±0.09
(T6)	8.72^a±0.27	0.55^a±0.26	2.65^b±0.10	9.82^b±0.26	0.89^a±0. 17	1.85^c±0.26	0.53^b±0.06

C1= Control (1), C2= Control (2), WAI =Water absorption index ,WSI= Water solubility index, OAI=oil absorption index: SV= Specific Volume.
Values are expressed as mean ± SD Means within a column showing the same letters are not significantly different (P≥ 0.05).

Color index of extruded and baked barley flakes

The color parameters of extruded and baked barley flakes were recorded in Table (6). This parameter (lightness $L*$ were $L* = 0$, black; $L* = 100$, white), is important because consumers are more familiar with snacks of light color, such as control made from corn or treatments made from naked barley, naked oats and unused baladi bread. $L*$ value of treatments was (59.50-64.12) which is lower than that of C1 and C2 (72.35 and 68.60 respectively). These results agreed with Gomes et al., (2015), who explained the luminosity reduction to be a result of the extrusion process. The same is true for corn flakes samples, $L*$ was reduced. The color coordinates $a*$ observed an increase with the replacement of corn by naked barley, oats and unused baladi bread. The lowest $a*$ value was found in C1 and C2 (2.0 and 2.1), flowed by T3and T6 (2.6 and 2.86) which were made from naked barley and unused baladi bread while the higher $a*$ values were found in T1, T2, T4 and T5 (3.31, 3.22, 3.41 and 3.23). This may be due to the dark color of barley and oats compared with yellow corn and unused baladi bread. These results can be, also, explained by the extrusion process causing a darkening of the product, chromaticity coordinates $a*$ to increase. The color acquired by naked barley and oats may be a result due to sugar caramelization or the occurrence of the Maillard reaction, since naked barley, and oats present a large quantity of dietary fiber and proteins (Carreiro et al., 2008). $b*$ value of T1, T2, T4 and T5 were (28.77, 28.85, 27.27 and 27.91) respectively, which is lower than that of T3 and T6 which were made from naked barley and unused baladi bread followed by T1 and T4 which made from naked barley only. While T2 and T5 which made from naked barley and oats were the lower blends in color properties, also, the extrusion method was the best method compared with the backing method.

Table 6. Color index of the extruded and baked barley flakes

Formulation	Color		
	L* (Lightness)	***a**** (Redness/greenness)	***b**** (Yellowness/blueness)
(C1)	72.35 [a]±0.28	2.00 [c]±0.26	32.48[a]±0.26
(T1)	61.48 [b]±0.23	3.31 [a]±0.26	28.77[b]±0.26
(T2)	62.52 [b]±0.26	3.22 [a]±0.26	28.85[b]±0.26
(T3)	64.12 [b]±0.31	2.60 [b]±0.26	29.56[b]±0.26
(C2)	68.60 [a]±0.22	2.10 [c]±0.26	30.12[a]±0.26
(T4)	59.50[c]±0.28	3.41 [a]±0.26	27.27 [c]±0.26
(T5)	60.10 [c]±0.24	3.23 [a]±0.26	27.91 [b]±0.26
(T6)	63.23 [b]±0.29	2.86 [b]±0.26	28.94 [b]±0.26

C1= Control (1) , C2= Control (2).Values are expressed as mean ± SD Means within a column showing the same letters are not significantly different (P≥ 0.05).

Sensory evaluation extruded and baked barley flakes

The sensory evaluation of the extruded and baked barely flakes, data was recorded in Table .7. The corn flakes made from corn flour were replaced with naked barley only or a mixture of naked barley with naked oats or a mixture of naked barley with unused baladi bread, and evaluating sensory attributes and comparing with corn flour control (1 and 2). The results showed that there was a significant increase in the taste odor, texture, color and appearance in C1 and C2 while (T2, T3, T5 and T6) flakes blends were slightly decreased in all sensory properties and significantly differed with control (1 and 2) and other blends. Therefore T1 and T4 were the lowest samples in sensory attributes and significantly differed with control 1 and 2 and other blends. The sensory attributes of barley flakes with mixed naked barley and naked oats or unused baladi bread also the yellow color of turmeric (T2, T3, T5 and T6) have the best scores in overall acceptability after C1 and C2 than other flakes samples. Thus, the extrusion method led to some improvement in the sensory attributes of barley flakes compared with the oven backing method. Since all sensory characteristics had good scores. It could be recommended that flake samples containing naked oats or unused baladi bread could be used in the preparation of high-quality flakes. The obtained results were in accordance with Abdelazim et al., (2019), who found using barley flour 25% to 100% in biscuits making led to the same results (Youssef, et al., 2016) also reported that with the increased level of oat flour in formulation, the sensory scores for color, odor, taste and overall acceptability of biscuits decreased, while based on our mentioned results flaxes containing both 10% oat were found to be most acceptable by the panelists had the best taste score according to judges' score.

Table 7. Sensory evaluation of prepared of extruded and baked barley flakes.

Blends	Taste	Odor	Texture	Color	Appearance	Overall acceptability
(C1)	8.10^{a}±0.19	8.00^{a}±0.26	8.20^{a}±0.21	8.33^{a} ±0.25	8.10^{a} ±0.23	8.40^{a}±0.19
(T1)	7.40^{b}±0.12	7.20^{b}±0.11	6.82^{c}±0.19	7.75 ^{b}±0.26	7.62^{b} ±0.19	7.10^{b}±0.27
(T2)	7.45^{b}±0.24	7.40^{b}±0.29	6.90 ^{b}±0.24	7.92^{a}± 0.15	7.71^{b}±0.17	7.42^{b}±0.18
(T3)	7.48^{b}±0.13	7.88^{a}±0.20	7.20^{b}±0.21	7.90 ^{a}±0.16	7.84^{a}±0.24	7.90^{a}±0.19
(C2)	7.90^{a}±0.22	7.80^{a}±0.11	8.00^{a}±0.26	8.12^{a}±0.10	7.70^{b}±0.15	8.00 ^{a}±0.25
(T4)	6.90^{c}±0.10	6.92^{c}±0.31	6.73^{c}±0.26	7.43^{b}±0.15	7.10^{c}±0.25	7.00 ^{b}±0.27
(T5)	6.90^{c}±0.19	7.00^{c}±0.23	6.80^{c}±0.17	7.56^{b}±0.11	7.26^{c}±0.23	7.20 ^{b}±0.17
(T6)	7.26^{b}±0.16	7.70^{a}±0.31	7.00 ^{b}±0.22	7.72^{b} ± 0.2	7.48^{b}±0.23	7.80 ^{a}±0.21

C1= **Control (1)** , C2= **Control (2)** .Values are expressed as mean ± SD Means within a column showing the same letters are not significantly different (P ≥ 0.05).

4. Conclusion

The present study was conducted to prepare flakes by incorporating naked barley with defatted coconut powder or mixture from naked barley with naked oats and defatted coconut powder or mixture from naked barley with unused baladi bread and defatted coconut, by using one of two methods of cooking. From the results, it is revealed that a blend of naked barley incorporated with naked oat and defatted coconut powder(T2 and T5), showed the best results with respect to their physicochemical properties, and functional properties as compared to other combinations. This work led to producing healthy flakes that could be used as food manufacturing products in the future and in therapeutic nutrition as the product has direct and indirect effects on growth as well as the development of human beings as they are rich in micro and macronutrients like dietary fiber,β–glucans, Total phenolic content, total flavonoid, minerals, protein, and energy value. These produced flake blends have better nutritional profiles as compared with flakes prepared from corn only also defatted coconut flour enhanced nutrients with great improvement in the total dietary fibre, protein content, bioactive compounds and antioxidant properties. Also, extrusion technology is the best technique to prepare barley flakes than oven baking**.**

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