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Annals of Biological Research, 2013, 4 (10):61-66
(http://scholarsresearchlibrary.com/archive.html)

Annals of Biological Research
Scholars Research Library
ISSN 0976-1233
CODEN (USA): ABRNBW

Effects of additional low fatted corn germ flour on rheological properties and sensory of macaroni

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ABSTRACT

Low fat corn germ flour is rich in minerals, proteins and certain essential amino acids such as lysine and can be used as a complementary food supplement. In this study, the rheological characteristics of adding 10, 20 and 30% of low fat corn germ flour to macaroni were evaluated. Different treatments were produced by industrial and semi-continuous production method and rheological and sensory analysis were performed according to standard methods. Results showed that by using more low fat corn germ flour, water absorption and dough development time increased but dough resistance and tensile reduced. Also resistance to stretch dough increased, tension ability reduced, ratio (tension resistance to tension ability index) increased and energy reduced. For sensory evaluations (color, taste, chewing ability and adhesion to the tooth) trained assessor were used. Results presented that two samples of macaroni containing 10 and 20% low fat corn germ flour were designated and more desirable. Then these samples along with control sample were given to home consumers for preferred test and finally presented that the sample of macaroni containing 10% low fat corn germ flour was selected as preferred sample. Samples containing 10% low fat corn germ flour had higher quality due to possessing rheological properties, baking and sensory characteristics.

Keywords: Low Fat Corn Germ Flour, Sensory Evaluation, Macaroni, Rheological Characteristic.

INTRODUCTION

Grain crops are the first agricultural products man used as food [10] and now among them wheat is the most used in the world due to its unique nutritional properties and technological characteristics [5]. One of its most consumed products is macaroni. Macaroni is a general term that encompasses a wide range of dough products, but it generally refers to a group of nutrients that result in mixing semolina (durum wheat flour) or hard or soft wheat flour or a mixture of two or more groups or one or more combinations of these materials with water and drying the obtained dough [19]. According to some historians, this product was introduced by Marco Polo from China to Italy in the year 1292 AD, and then to other countries [10].

Various types of wheat flour is used for macaroni and pulp products, but due to the semolina protein quality and quantity and desirable rheological properties of durum wheat, the appropriate color and cooking quality of macaroni, makes it one of the best nutritional raw material worldwide [16]. Macaroni nutritional value alters due to the type of wheat and additional ingredients or additives used in its production formula. Generally, differences in grains composition or different techniques milling does not influence the nutritional value of products and the major differences between macaroni various products results from the use of substances such as egg, spinach, tomatoes, vegetable protein or concentrates, dairy products and also vitamins and minerals. These products are recommended due to low amounts of sodium, fat, saturated fatty acids, cholesterol and high carbohydrate consumption.

However, macaroni products, like any other food source, do not provide all the nutritional needs of humans [20]. that non-fat corn germ meal In recent years the usage of additives in order to increase the quality and properties of macaroni has been in consideration and various compounds such as active gluten, monoglycerides ,water cheese powder, wheat bran, various vitamins and minerals have been tested and even some of which are used in the industry [14]. Low fatted corn germ flour is another additive that can be used in macaroni production. Studies have shown contains approximately 29-25% protein, 5.1% lysine, 4% glucose, 0.5% fat and 10% ash [25]. A suitable mixture of low fat corn germ flour with wheat flour, produce a product with high protein biological value which adjust the amino acid deficiency in both grain. 12 percent of corn seed includes corn germ which is higher compared to other cereals [2]. The quality and quantity of corn germ protein due to its albumin and globulin is higher than endosperm and the limitation of some amino acids (especially lysine and methionine) in corn protein is due to the endosperm protein.

Corn germ is used for producing flour, starch and corn oil [17], is rich in minerals and proteins. It contains essential amino acids such as lysine [12, 24]. In other words, while corn germ is suitable for oil extraction, its meal is suitable for corn germ flour production [3]. Corn flour germ has many applications as a supplementary food because it contains high amounts of protein and useful mineral such as phosphorus, potassium, magnesium, sodium, calcium, iron, zinc and copper [6]. Corn germ improves various properties such as dissolution vulnerability, water absorption, heat stability, gelatin production, emulsion stability and foam production [13]. Flour produced by low fatted corn germ flour is a byproduct in oil corn industry is rich in protein, fibers and minerals [9] and can be a suitable substitute for soya products [17].

The quality of low fat corn germ flour has been favorable because of its albumin and globulin proteins [7] and its protein output efficiency is similar to soybean [21]. The amount of protein in corn germ is very high and the composition of its essential amino acids is balanced [7] so that it can be used in order to compensate the shortage of amino acids in children nutrition according to FAO/WHO standards [22]. The water bonding capacity of corn germ is even higher than the ability of cheese and soybean water absorption [8, 26].

In addition, the corn germ protein emulsion properties is favorable [27] which preserves colloid systems [17]. Blessin *et al.* (1972) showed that cookies and muffins could be backed with wheat flour enriched with 25 percent low fat corn germ flour in order to increase the quality of these products. Peri *et al.* (2007) produced snacks with 85 percent corn germ flour and different quantities of corn starch and milk proteins. Tsen *et al.* (1974) showed that acceptable bread is produced under optimal amounts of wheat flour enriched with 12 percent low fat corn germ flour. They also showed that adding sodium stearyl-2-lactylate (SSL) and monoglyceride ethoxylate (EM) is useful for cooking breads with high levels of protein and enriched with 12 percent low fat corn germ flour .

MATERIALS AND METHODS

Null wheat flour with a 65-70 percent extraction and low fat corn germ flour were prepared. Low fat corn germ flour was added to the null wheat flour in the amounts of 10, 20 and 30 percent and was used for industrial production of spiral macaroni by semi-continuous method. The treatments in this research were G_0 as control (null wheat flour) and G_1, G_2 and G_3 (null wheat flour with 10, 20 and 30 percent low fat corn germ flour respectively).

Chemical tests on wheat flour included moisture (according to AACC 44-16), pH (according to AACC 2-52), ash (according to AACC 08-01), protein (according to AACC 46-12), alluvial number (according to AACC 116), raw fiber (according to AACC 32-10), wet and dry glutin (according to AACC 38-11). Chemical tests on low fat corn germ flour included moisture (according to AACC 44-16), pH (according to AACC 2-52), ash (according to AACC 08-01), protein (according to AACC 46-12), fat (according to AACC 30-10) and raw fiber (according to AACC 32-10). Also chemical tests on macaroni samples included ash and protein according to the above mentioned standard methods. PICO TAG method by using HPLC and UV detector was used in order to determine the samples of macaroni including 10, 20 and 30 percent corn germ flour amino acids quality and quantity. Instron test was conducted according to the international standard AACC 74-09 [1]. Questionnaire forms were prepared for sensory tests and four trained evaluator were used as panelist in order to evaluate characteristics including shape, color, taste and adherence ability to the teeth, ranking from 1 (desirable) to 5 (undesirable). Also two chosen samples with control were evaluated by 50 domestic consumer (untrained evaluators) based on prefer method according the Tehran Bread and Grain Research Center forms. Statistical analysis was done with SAS (version 9.1.3) statistical software. Duncan method was used for means comparison.

RESULTS AND DISCUSSION

The results of chemical tests on wheat null flour and low fat corn germ flour used in this study are shown in Tables 1 and 2 respectively.

Table 1. Chemical tests on wheat flour

	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Row fiber (%)	Moist gluten (%)	Dry gluten (%)	Zeleny number(%)	pH
Null flour	14.2	0.433	9.81	0.012	1.047	28.1	9.8	23	6.18

Table 2. Chemical tests on Low Fatted Corn Germ Flour

	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Row fiber (%)	pH
Low fat corn germ flour	2.57	1.942	19.77	1.89	9.095	4.46

Chemical test result

A significant difference observed among treatment for protein and ash percentage (Table 3).

Table 3. Analysis of variance for chemical traits

		Mean square	
SOV	**df**	**Protein**	**Ash**
Replication	2	0.016 ^{ns}	0.002 ^{ns}
Treatment	3	6.971 **	0.120 **
Error	6	0.107	0.004
CV %	-	2.599	10.329

*ns: non-significant; ** significant at p<0.01.*

As shown in Table 4, adding low fat corn germ flour to null wheat flour increased protein percentage from 11.06 (G_0) to 14.43 (G_3). Ash also increased from 0.36% (G_0) to 0.78 (G_2 and G_3).

Table 4. Mean comparisons for chemical traits

Treatment	Protein (%)	Ash (%)
G_0	11.06 d	0.36 c
G_1	11.72 c	0.56 b
G_2	13.3 b	0.78 a
G_3	14.43 a	0.78 a

Means with similar letters are not significantly difference at P< 0.05 according to Duncan multiple tests. G_0: control, G_1: 10% corn germ flour, G_2:20% corn germ flour and G_3: 30% corn germ flour.

Sensory and Inestron test result

Sensory characteristics of macaroni samples were ranked by trained panel. Due to Table 5, a significant difference was observed among treatments for flavor. As shown in Table 6, by adding more than 10 percent low fat corn germ flour decrease flavor favorableness. But by adding low fat corn germ flour, treated samples color decreased and became darker. Both These results has also been reported by Lucisano *et al*. (1984). Regarding teeth stickiness (Table 5 and 6), no significant difference was observed between control (null wheat flour) and G_1, G_2 and G_3 (null wheat flour with 10, 20 and 30 percent low fat corn germ flour respectively).

Table 5. Analysis of variance for sensory and inestron

		Mean square			
SOV	**df**	**Flavor**	**Color**	**Stickiness**	**Maximum pressure**
Replication	3	0.368 **	0.712 **	0.0104 ^{ns}	9514.138**
Treatment	3	0.054 **	0.035 ^{ns}	0.0104 ^{ns}	483.95**
Error	9	0.006	0.025	0.0313	47.265
CV%	-	4.033	8.751	2.657	6.825

*ns: non-significant; ** significant at p<0.01.*

Treatments G_0, G_1 and G_2 were also been evaluated for sensory characteristics by a group of 50 house consumers (untrained persons). Based on preferred test the group members evaluated the samples color, flavor, taste, chewing ability and teeth stickiness. These results are shown in Figure 1. As it could be seen, the result indicates that G_1 treatment was preferred among G_0 and G_2.

Table 6. Mean comparison for sensory and inistron tests

Treatment	Flavor	Color	Stickiness	Maximum pressure (N m^2)
G_0	2.06 a	2.177 a	5 a	43.13 d
G_1	2.177 a	2.118 a	5 a	82.49 c
G_2	1.799 b	1.573 b	5 a	121.2 b
G_3	1.493 c	1.311 b	4.75 a	156.1 a

Means with similar letters are not significantly difference at P< 0.05 according to Duncan multiple tests. G_0: control, G_1: 10% corn germ flour, G_2: 20% corn germ flour and G_3: 30% corn germ flour.

According to Tables 5 and 6 and Figure 3, the inestron test showed a significant increment from G_0 to G_3. In other words, adding low fat corn germ flour increased macaroni hardiness from 43.13 N m^2 (G_0) to 156.1 N m^2 (G_3). This result is similar as Lucisano *et al*. (1984) reported.

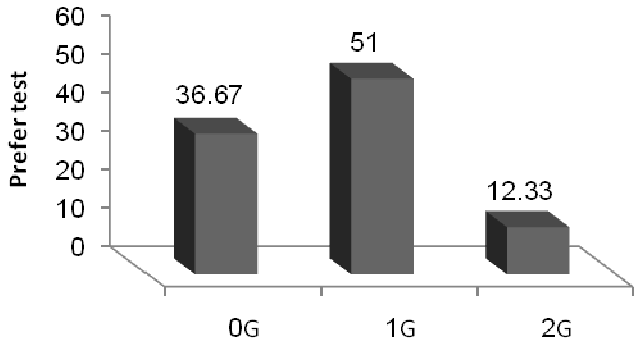

Figure 1 House consumer prefer test result

Amino acids profile results

As G_1 was preferred by both trained and untrained evaluators, therefore the profile of amino acid was determined for G_0 and G_1. According to Table 7 and Figure 2, the amount of amino acids increased by adding low fat corn germ flour. Cysteine and Glutamine acid had the highest (58.33%) and lowest (4.1%) percent of increment respectively. Also the highest increase of essential amino acid percentage was Histidine (40.9), Arginine (33.33) and Tyrosine (31.25) respectively and the lowest increment was Isoleucine (17.65). Lucisano *et al*. (1984) reported similar result. Low fat corn germ flour is rich in minerals and proteins. It's also Lysine rich which is twice as much as corn and wheat flour [12, 24].

Table 7. Amino acids profile results

Amino acid	G_0 (mg/g)	G_1 (mg/g)	Difference	
			Amount (mg/g)	percent
Lysine*	2	2.6	+ 0.6	+ 30
Methionine*	1.2	1.5	+ 0.3	+ 25
Histidine*	2.2	3.1	+ 0.9	+ 40.9
Leucine*	5.9	7.1	+ 1.2	+ 20.33
Isoleucine*	3.4	4	+ 0.6	+ 17.65
Phenylalanine*	4.2	5.1	+ 0.9	+ 21.43
Valin*	3.9	4.7	+ 0.8	+ 20.51
Arginine*	3.3	4.4	+ 1.1	+ 33.33
Cysteine	1.2	1.9	+ 0.7	+ 58.33
Threonine*	2.8	3.5	+ 0.7	+ 25
Asparagine	3.5	4.4	+ 0.9	+ 25.71
Glutamine	34.1	35.5	+ 1.4	+ 4.1
Proline	10.7	11.7	+ 1	+ 9.34
Alanine	2.8	3.5	+ 0.7	+ 25
Glycine	3.1	3.9	+ 0.8	+ 25.81
Tyrosine*	1.6	2.1	+ 0.5	+ 31.25
Serine	4.4	5	+ 0.6	+ 13.63

**essential amino acids*

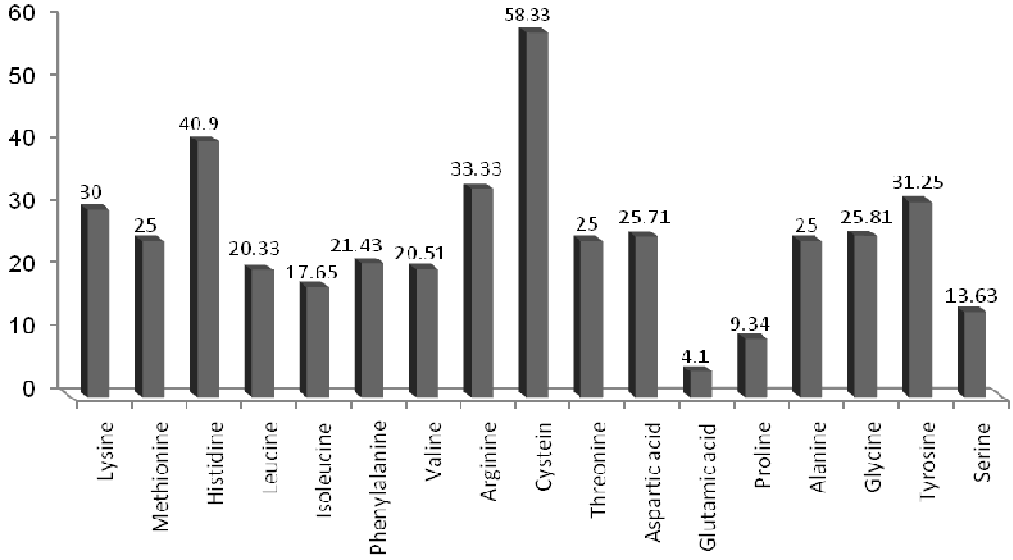

Figure 2 - Percentage change amino acids in the sample containing 10% corn germ flour and fat than the control sample (no flour, corn germ, nonfat)

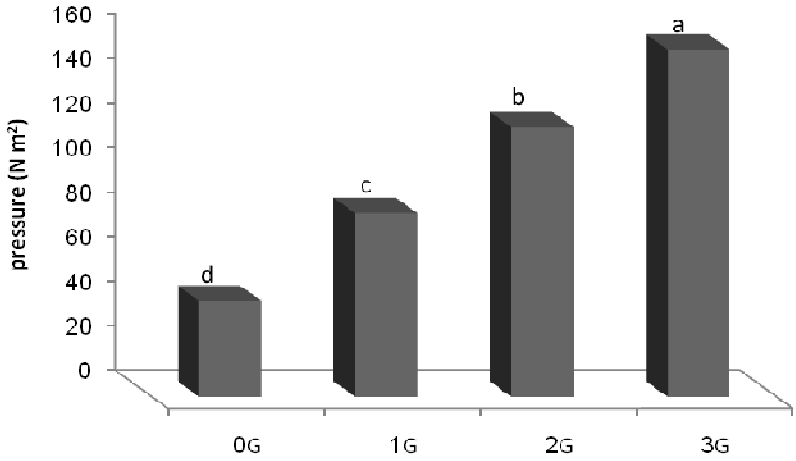

Figure 3 - Effect of different levels of corn germ flour and fat before cooking pasta on the amount of force the sample

CONCLUSION

Our results showed that adding low fat corn germ flour had different effects on physico-chemical parameters, nutrition and sensory characteristics of the product. By adding low fat corn germ flour to macaroni and the amount of protein and essential amino acids including histidine, arginine, tyrosine, lysine and phenylalanine significantly increased compared to control. The results indicated that considering protein amount, G_3 was more desirable than G_1. The addition of low fat corn germ flour increase macaronis hardiness before cooking.

Regarding sensory test, by increment of enrichment, deficiency of some macaroni characteristics occurred as evaluators preferred control samples (G_0) and G_1 was subsequently preferred. Totally although none of the treatments achieved all desirable characteristics but 10 percent low fat corn germ flour overall is preferred. Therefore considering the results, adding 10 percent low fat corn germ flour could be recommended to produce macaroni with higher quality.

According to the results obtained in this study we suggest further research on the addition of low fat corn germ flour on food products such as bread, cakes and biscuits. Examination of other cereal flours on manufacture of macaroni product. Effects of protein isolates obtained from maize germ flour be tested on macaroni. Also the biological value of macaroni produced by the incorporation of other values of corn germ flour be determined..

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