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EFFECT OF DEFATTED SESAME FLOUR ON THE RHEOLOGICAL PROPERTIES AND BAKING QUALITY OF COOKIES

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ABSTRACT

The present study was conducted to evaluate the effect of adding defatted sesame flour (DSF) to hard wheat flour (HWF) on the rheological properties, baking quality, chemical composition and amino acid profile of cookies. Defatted sesame flour at levels of 5, 10, 15 and 20 % was added to hard wheat flour. Chemical composition of the used raw materials showed that defatted sesame flour had a high content of protein, fiber and ash. The addition of defatted sesame flour to the hard wheat flour, at any level studied, markedly decreased the dough stability and increased the tolerance index and water absorbition of the resultant dough. Such addition led also to slightly and gradually improve in the measured baking quality, since the spread ratio of the control which was 4.96 increased to 5.07, 5.22, 6.42 and 5.72 when the DSF was added at levels of 5, 10, 15 and 20 %, respectively. The total score average of the organoleptic quality of the resultant cookies increased as the supplementation level increased up to 15%. The protein content of the supplemented cookies increased by increasing level of replacement, as well as all essential amino acids, including sulfer amino acids, were increased. It is of importance to indicate that by adding defatted sesame flour to wheat flour in cookies industry, it is possible to adequate its strength that led to produce uniform quality of the final product. The chemical composition and amino acid profile of the resultant cookies were improved as well.

INTRODUCTION

The availability of a continuous supply of soft wheat flour that produces a uniform and super quality biscuit is always one of the main difficulties in cookie industry. Unfortunately, the problem is more complicated in Egypt because of the importation of wheat or wheat flour of various strengths from several countries and the inadequate storage facilities in most of the production. As general, the cookies from soft wheat flour was thicker and of larger diameter, volume, specific lightness and specific volume than cookies from hard wheat flour (Damir *et al.*, 1976). Accordingly, the food additives or food suplemented substanses which led to weak the wheat flour should be used with hard wheat flour for producing high quality of cookies. Among these substanses, rootlets (Makhlouf, 1991; Ragab, *et al.*, 1997), legume flour (Hegazy and Fahid, 1991), and oilseeds meal (Roony et al.,1972; Ramadan,1991).

In addition to their effects on the wheat flour strength, legume grains together with oilseeds are the promising type of crops for protein production. Although legumes are known to be deficient in metheonine, they are a source of a substantial quantity of lysine (Fahmey *et al.*, 1981) and, therefore, are a good source of protein (Hoover, 1979; Hassan, 1980). On the other hand, by-product of pressed seeds as cake or meal left after oil extraction from oil crops could be considered as one of the most potentially useful sources of protein for human consumption (Sebrell, 1969). This protein is of high quality because the balance of amino acids is more suited to human nutrition than that found in cereal protein. Therefore, there is an increasing interest in fortification of bread and other cookies by replacing a part of wheat flour with nonwheat flours, especially high protein concentrates and oilseed flours (Dendy *et al.*, 1970).

Sesame (*Sesamum indicum*) is an important annual oilseed crop that has been cultivated for canturies, particularly in Asia and Africa, for its high content of edible oil and protein (Salunkhe *et al.*, 1992). Although dehulled sesame seeds are mainly utilized in the production of *Tehineh* (sesame butter) and *Halawah* (halava) particularly in Middle East, the oil is the majore product of sesame processing (Maiti *et al.*, 1988). Most of the oil produced is used for culinary purposes because of its nutty flavor and its excellent stability at room temperature (Salunkhe *et al.*, 1992). The protein-rich meal remaining after oil extraction from sesame seeds is an important and valuable food raw materials since it could be mixed with cereal grains to produce a product more adequate in biological value which might be high enough to fulfill the protein requirement of human (Scrinshaw *et al.*, 1960).

Previous reports have noted the beneficial effect of sesame addition on the nutritional value of cereal grains. When sesame flour used as a part replacement for wheat flour, it performed well in breadmaking (Glabe, *et al.*, 1957; Rooney *et al.*, 1972). Unlike many oilseeds, defatted flour and isolates prepared from sesame seed do not contain any undesirable pigments or off-flavours. The maximum level of replacement depends on the type of nonwheat flour, the strength of the wheat flour, the baking procedure, and the dough stabilizing compounds used (Dendy *et al.*, 1970; Pringle *et al.*, 1969).

Therefore, this investigation was conducted to try to help in solving the dificient in soft wheat flour suplies through incorporating the defatted sesame flour (DSF) to hard wheat flour to improve the cookie measures and quality made of such flour. Improve the nutritianal quality of the resultant cookies is the second aim of this investigation. In this study DSF at levels of 5, 10, 15 and 20 % were incorporated to the hard wheat flour and their effect on rheological properties of the resultant doughs and baking quality of the manufactured cookies were evaluated, the chemical composition and amino acid profile of such cookies were recorded as well.

MATERIALS AND METHODS

Materials

Hard wheat flour was obtained from North Cairo Flour Mills Company. This was at 72 % exteraction. Sesame seeds (*Sesamum indicam*) as well as the other materials used, i. e., vegetable shortening, commercial grade crystalline sucrose, salt, baking soda and vanilla, were obtained from the local market, Cairo, Egypt.

Methods

Preparation of Defatted Sesame Flour (DSF)

Defatting was carried out a described by Morcos *et al.* (1981). The seeds were roasted in drying oven at 80°C for 12 hours, then left to cool. Sesame kernels were ground into a thick paste using an electric blender. The sesame butter obtained was pressed in a hydraulic press to get rid of most of the oil. The obtained dry cake was washed several times with ether. A fine sesame cake obtained left in air for one houre, then a current of hot air was passed over the defatted sesame till it became free from any trace of ether odor, ground and sieved through an 80 mesh screen.

Baking performance of different cookie blends

Cookies were prepared according to Abd EL-Magied *et al.* (1991). The Defatted Sesame Flour (DSF) was used to replace wheat flour at levels of 0, 5, 10, 15 and 20 %. The basic formula was presented in table (1). The flours, baking soda powder and vanilla were mixed in a kitchen mixer. The shortning was melted and mixed with the sugar and added to the previous mixture, followed by a portion of water was also added in the mixing bowl. This was then made up into a smooth paste with the gradual addition of the remaining water. Dough was shaped in a cookie moder and baked on sheets for 10 min. at 170° C in ordinary oven. The baked cookies were cooled at room temperature and then packed in polyethylene bags.

Table (1): The formula used for cookies.

Sample	DSF*		HWF**	Water	Sugar	Shortining	Salt	Na H CO_3	Vanilla
	g	%	g	ml	g	g	g	g	g
1	0.0	0	450.0	15.0	260.0	128.0	2.0	5.0	5.0
2	22.5	5	427.5	15.0	260.0	128.0	2.0	5.0	5.0
3	45.0	10	405.0	15.0	260.0	128.0	2.0	5.0	5.0
4	67.5	15	382.5	15.0	260.0	128.0	2.0	5.0	5.0
5	90.0	20	360.0	15.0	260.0	128.0	2.0	5.0	5.0

* Defatted sesame flour.
** Hard wheat flour.

Analytical methods

Moisture, crude protein, fat, ash and crude fiber were determined according to the AOAC approved methods (1995). Amino acids were determined according to the method described by Pellett and Young (1980), using a LKB 4151 Alpha plus Amino acid Analyzer. Food Tech. Central Lab. Of the Faculty of Agric., Cairo Univ. Amino Acid Score (AAS) was calculated according to the FAO/WHO (1973) as follows :

AAS(%) = (mg amino acid in 1gm test protein / mg amino acid in reference protein) X 100

Rhelogical properties of the dough

Water absorpation and mixing characteristics of used flours were determined by using a Brabender Farinograph as dscribed by AACC (1983).

Baking quality of cookies

Baking quality tests were conducted according to the methods described by AACC (1983). The tests were included cookies weight, volume, specific volume, diameter, thickness and spread ratio. The spread ratio was calculated as the average diameter/ average thickness.

Organoleptic qualities

The organoleptic characteristics of cookies were examined accrding to Zabik and Hoojjat (1984) by ten staff member and graduate students of the Focd Science and Technology Dept., Nat. Res. Cen. Dokki, Cairo, Egypt.

Statistical analysis

The data obtained from the sensory evaluation were subjected to statistical analysis according to Senedecor and Corhoran (1967).

RESULTS AND DISCUSSION

Chemical composition of the used materials:

The chemical analysis of the hard wheat flour along with the DSF is presented in table (2). The data illustrated that crude fiber and ash content of DSF (3.0 and 2.95%) was higher than that of HWF (0.5 and 0.46%, respectively). The protein content indicates that the DSF may considered the highest protein source (49.55%) while the HWF was contain a normal protein content for such kind of flour being 11.15%. The higher protein content of the DSF compared to HWF reflect the lower content of total carbohydrate in the DSF compared to HWF as shown in the same table.

Table (2): Chemical composition of the hard wheat flour and defatted sesame flour (%, on dry weight basis).

Constituent	Wheat flour	Defatted sesame flour
Moisture	13.15	8.05
Ash	0.46	2.95
Ether extract	1.30	1.48
Crude protein	11.15	49.55
Crude fiber	0.50	3.0
Total carbohydrate	74.44	34.97

Effect of DSF on the rheological properties of dough

The effect of DSF on the rheological properties of wheat flour are recorded in table (3). Wheat flour absorption was lower than those containing DSF. As well as, wheat flour developed and broken faster than those containing DSF. The weak dough and low absorption of wheat flour most likely due to the difference in gluten quality and quantity (Ibrahim, 1988). The water absorption of wheat flour was 60.8% which was increased by 6.7, 6.9, 8.4 and 15.0% compared to control upon adding of DSF by concentration of 5.0, 10.0, 15.0 and 20.0%, respectively. The water absorption of flour was affected by its protein, bran contents, starch damage, granulation and many other factors (Ander, 1970; El-Nemr *et al.*, 1980; Halim and Lorenz, 1985). Arrival time of wheat flour was 1.20 min. which was increased by 0.1, 0.3, 0.4 and 1.8 min. compared to control as DSF was incorporated by percentages of 5.0, 10.0, 15.0 and 20.0%, respectively.

Table (3): Effect of defatted sesame flour on the rheological properties of hard wheat flour.

Sample* No.	Water Absorption (%)	Arrival time (min)	Peak time min	Departure time (min)	Dough stability (min)	Tolerance index (B.U)
1	60.8	1.2	1.7	10.7	9.5	20.0
2	67.5	1.3	1.7	8.3	6.8	40.0
3	67.7	1.5	2.5	8.0	6.4	45.0
4	69.2	1.6	2.0	4.3	3.0	50.0
5	75.8	3.0	8.5	4.7	1.7	75.0

*** Refer to table 1.**

Departure and dough stability times of wheat flour were continuously and markedly decreased upon adding increased amounts of DSF, which led to gradually decrease its strength. The wheat flour dough stability relative to addition of 5, 10, 15 and 20% DSF were 6.8, 6.4, 3.0 and 1.7 min., respectively, while it was 9.5 min for control. It is appeared that a moderate and continuous decrease in dough stability could be obtained upon adding increment amounts of DSF and the highest decrease in dough stability was 7.8 min. for 20% DSF level. However, this treatment moderately increased the tolerance index of the flour, where the increases in the tolerance index were 20, 25, 30 and 55 B.U. upon adding 5, 10, 15 and 20% of DSF, respectively. In general, the observed decrease in dough stability as a result of adding DSF to the wheat flour under the present investigation might be due to the DSF itself, since it riches in sulfer amino acids which causes a decrease in dough stability. In this regard, El-Farra *et al.* (1985) mentioned that the decrease in dough stability may be due to protein rich in sulf-hydryl groups which normally cause a softening or degradation action of the dough. The obtained results suggested that it could be used the DSF to weak the hard wheat flour for produce some products, i.e., for cookies production.

Effect of DSF on the baking quality of cookies.

The effects of DSF added to wheat flour on the baking quality characteristics of the resultant cookies are shown in table (4). It is obviously that the addition of DSF up to 15% resulted in improving the measured baking quality of cookies made from hard wheat flour. Generally, using hard wheat flour in making cookies produced very poor characteristics and quality measures. The addition of increased amount of DSF to the hard wheat flour led to slightly and gradually improve in the measured baking quality, since the spread ratio were 5.07, 5.22, 6.42 and 5.72 when the DSF was used by levels of 5, 10, 15 and 20 %, respectively, which was 4.96 for control.

Table (4): Effect of defatted sesame flour on the baking quality of cookies.

Sample* No.	Weight gm	Volume cc	Spic. vol. cc/gm	Diameter cm	Thickness cm	Spread ratio	Spread ratio (%)
1	25.45	39.50	1.55	6.90	1.39	4.96	-
2	26.13	42.00	1.61	6.99	1.38	5.07	2.22
3	26.95	42.25	1.57	6.99	1.34	5.22	5.24
4	28.5	43.00	1.51	7.38	1.15	6.42	29.44
5	23.14	35.00	1.51	7.09	1.24	5.72	15.32

* Refer to table 1.

Effect of DSF on the organoleptic properties of cookies.

The effect of DSF on the organoleptic properties of cookies made from hard wheat flour is shown in table (5). It could be noted that the addition of DSF to the hard wheat flour resulted in increasing the total score average of the organoleptic quality of the resultant cookies. Increasing the supplementation level more than 15%, i.e., 20%, led to lower the total score average of the manufactured cookies. The same observation was noticed with respect to odor and bite. The statistical analysis of the obtained data revealed that there is insignificant differences between the total score average of the samples mixed with DSF by concentration of 5, 10 and 15% and the total score average of the control sample, but a significant difference was obtained when the sample was contained 20% DSF.

Table (5): Effect of defatted sesame flour on the organoleptic properties of cookies made from hard wheat flour.

Sample	Color	Appearance	Odor	Bite	Taste	Overall score
1	7.4^{ab}	7.6	8.9^{a}	9.0^{a}	7.8	8.16
2	7.4^{ab}	7.7	8.8^{a}	8.5^{a}	7.8	8.02
3	7.1^{b}	7.8	8.6^{a}	8.5^{a}	7.8	7.96
4	8.2^{a}	8.2	8.3^{a}	9.0^{a}	8.2	8.38
5	8.2^{a}	8.2	7.6^{b}	7.9^{c}	8.2	8.02

* Refer to table 1.

a, b, c, ...; Means having different letter exponents are significantly different ($p > 0.01$).

Chemical composition and amino acid profile of the cookies:

The chemical composition of cookies supplemented with defatted sesame flour (DSF) are presented in table (6). It could be noticed that protein content of the supplemented cookies increased by increasing level of replacement. This is mainly due to the higher content of protein in the DSF (Table, 2) and the increasing levels in the formula (Table, 1). The protein content of the cookies reached 20.10% at replacing level of 20% compared with the unsupplemented cookies which having 6.4%. At the same time , ash and fiber contents of the supplemented cookies tended to increase by increasing the level of added defatted sesame flour (DSF). On the contrary, total carbohydrates tended to decrease with increasing the supplementation level. These results are in agreement with those reported by Morcos *et al.* (1981), Ramadan (1991) and Fatma – Hassan *et al.* (2001). Moisture content of the cookies supplemented with defatted sesame flour decreased relatively by the supplementation level.

Table (6). Chemical composition of different cookies samples (%, on dry weight basis).

Sample*	Moisture	Protein	Fiber	Fat	Ash	Carbohydrate**
1	1.91	6.40	0.50	15.00	0.70	75.49
2	1.50	8.90	0.70	14.53	0.82	71.55
3	1.31	10.10	1.22	14.50	0.91	71.96
4	0.91	15.99	1.83	14.40	1.73	65.14
5	0.74	20.10	2.40	14.30	2.57	59.89

* Refer to table 1. ** By differences.

Table (7) shows the comparison of amino acid pattern of unsupplemeted cookies (control) and those supplemented with DSF at the levels 5,10,15 and 20%. Results indicated that addition of DSF caused an increase in all essential amino acids content of the resultant cookies. Sulfer amino acids content (methione and cysteine) of the supplemented cookies also increased. The increment reached 3.36 gm\100 gm protein when 20% DSF was added to cookies compared with control which had 2.53 gm\100gm protein. Whilest, lysine content (as the first limiting amino acid) of the supplemented cookies did not increase. The amino acid scores (AAS) of the supplemented and unsupplemented cookies are shown in the same table. Such scores indicated that some of essential amino acids increased in the supplemented cookies compared to the control, probably due to higher content of these amino acids in DSF than in HWF. These amino acids including therionine, sulfur amino acids and leucine.

Table (7): Essential amino acid content (gm/100 gm protein) and chemical score (%) of supplemented cookies with defatted sesame flour.

EAA	Samples*					WHO	Amino acid score				
	1	2	3	4	5	1973	1	2	3	4	5
Threorine	1.83	1.89	1.95	2.01	2.06	4.10	44.6	46.1	47.6	49.0	50.2
Cystine + Methionine	2.53	2.74	2.95	3.16	3.36	3.50	72.3	78.3	84.3	90.3	96.0
Valine	3.99	3.99	3.98	3.98	3.97	5.00	79.8	79.8	79.6	79.6	79.4
Isoleucine	3.00	3.0	3.00	3.00	3.00	4.00	75.0	75.0	75.0	75.0	75.0
Leucine	3.65	3.74	3.83	3.91	4.0	7.00	52.1	53.4	54.7	55.9	57.1
Tyrosine + Phenylalanine	7.69	7.65	7.60	7.56	7.51	6.00	128.2	127.5	126.7	126.0	125.2
Lysine	2.33	2.33	2.33	2.33	2.33	5.50	42.4	42.4	42.4	42.4	42.4

* Refer to table 1.

Coclusion

From the aforementioned results, it could be concluded that the use of DSF with hard wheat flour used for cookies industry will solve the problem of producing various quality standard cookies, from the same factory, that related to use wheat with different strength. In another words, by adding DSF to wheat flour in cookies industry, it is possible to adequate its strength that led to produce uniform quality of the final product. Moreover, the resultant cookies well have good nutritial quality refered to the protein content and amino acid patter.

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تأثير دقيق السمسم منزوع الزيت على الخواص الريولوجيه وخواص البسكويت المنتج

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تم دراسة تأثير إضافة دقيق السمسم المنزوع الزيت إلى دقيق القمح القوى على الخواص الريولوجيه وخواص البسكويت المنتج ، وكانت نسبة الاضافة ٥% و ١٠% و ١٥% و٢٠% . وقد أوضح التحليل الكيماوى ارتفاع نسبة البروتين والألياف والرماد وانخفاض نسبة الكربوهيدرات فى دقيق السمسم المنزوع الزيت بالمقارنة بدقيق القمح المستخدم . كما أوضحت النتائج أن اضافة دقيق السمسم المنزوع الزيت - إلى الدقيق المستخدم - بأى نسبة من النسب المستخدمة يؤدى إلى تحسين الخواص الريولوجيه حيث أعطت نتائج ايجابيه تتمثل فى انخفاض ثبات العجينة وزيادة معدل الصمود بدرجة واضحة أى أن الاضافة قد أدت إلى إضعاف العجينة الناتجة وجعلها أكثر ملاءمة لانتاج البسكويت . كما وجد أن معدل امتصاص الماء ارتفع بنسبة ملحوظة فى العينات المدعمة عن عينة المقارنة ، وقد يرجع ذلك إلى ارتفاع نسبة الألياف فى المادة المضافة . أما تأثير دقيق السمسم المنزوع الزيت على خواص الخبيز تتمثل فى أنه أعطى نتائج ايجابية حيث ظهر هذا من خلال تحسن معدل الانتشار والحجم النوعى للبسكويت الناتج وان كانت النتائج المتحصل عليها تختلف باختلاف نسبة الاضافة ، حيث وصلت نسبة التحسن فى الدقيق القوى إلى ٢٩,٤٤% عند إضافة ١٥% دقيق السمسم المنزوع الزيت . ومن ناحية أخرى فإن نتائج التقييم الحسى تثبت أن اضافة دقيق السمسم المنزوع الزيت يؤدى إلى تحسين الصفات الحسية للبسكويت المنتج . ويجدر الاشارة إلى أن إضافة دقيق السمسم المنزوع الزيت إلى دقيق القمح يؤدى إلى زيادة نسبة بعض الأحماض الأمينية الأساسية وخاصة الكبريتية منها . وعموما فان النتائج المتحصل عليها تشير إلى إمكانية استخدام دقيق السمسم المنزوع الزيت لضبط درجة قوة الدقيق المستخدم فى صناعة البسكويت مما يؤدى إلى توحيد درجة الجودة للمنتج ، الأمر الذى يساهم فى حل المشكلة القائمة فى صناعة البسكويت والتى تتمثل فى انتاج بسكويت بدرجات جودة متفاوته نتيجة استخدام دقيق ذات درجات قوة مختلفة ، كما أنه يؤدى إلى تحسين القيمة الغذائية للبسكويت الناتج .