NEW APPROACH FOR USING WHEAT GERM IN COOKIE PRODUCTION

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ABSTRACT

The chemical composition of white and red wheat germ varieties was determined. Also the rheological properties and the possibility of mixing processed germ flour with wheat flour for cookie production were studied. Red wheat germ was characterized by its higher crude protein, ash phytate phosphorous, carotenoids and lower oil and carbohydrates than white wheat germ. Oil of both vatieties showed high content of total unsaturated fatty acids (79.03 and 85.61 %) and linoleic was the predominant fatty acid. Unsaponifiable matter showed high percentage of hydrocarbons (72.85 and 82.27 %) and the main hydrocarbon was C_{28} (60.23 and 58.93).

Amino acid pattern showed that glutamic, proline, phenylalanin and asparatic acids were the most abundant amino acids, and that cystine and methionine were present in minute quanties. Both wheat germ varieties were rich in lysine (5.25 and 4.64 g/100 g protein).

Addition of processed wheat germ to wheat flour weekend the dough and reduced the parameter values of the extensograph. Satisfactory cookie measures and organoleptic characteristics could be obtained by mixing 10 % wheat germ with wheat flour (72 % extraction) for cookie production.

INTRODUCTION

Wheat germ is usually consumed in the preparation of special germ breads. Protein is highly concentrated in the germ. Peterson (1965) reported wide range of 22-32% for wheat germ protein content while, Bolling et al., (1973) reported 21.8%. The high protein content and amino acid balance of germ made it attractive for enriching wheat flour. It was found that a mixture of some cereals flour and 10 to 15 % defatted germ flour strikingly improved the nutritive value (Pomeranze et al. 1970). However, such fortification affect dough properties and baking quality due to weakening the rheological properties (Tsen, 1980). Oil is

one of the chief components of wheat germ, lipids ranged from 9-11% (Peterson, 1965 and Maruzzi et al., 1969). Also, it contained large proportion of essential unsaturated fatty acids (Refai, 1965). Wenlock et al., (1983) pointed out that processed wheat germ contains carotenoids (12.76 ppm.), vitamin B complex (thiamin, riboflavin, nicotinic acid, vit. B_6 and folic acid) and tocopherol (0.025 %). Cereal grains are rich source of phytate phosphorous (O'Dell et al., 1972).

The aim of this investigation is to study the chemical composition of wheat germ and the effect of wheat germ addition to wheat flour on the rheological properties of the dough as to evaluate the produced cookie.

MATERIALS AND METHODS

White and red wheat germ and wheat flour (72 % extraction rate) were purchased from Fouad Flower Mill, North Cairo, Flour Milling Company. The oil was extracted from the wheat germ according to the method of A.O.A.C. (1980).

Determination of fatty acids and unsaponifiable matter contents:

Methylation of the fatty acids was achieved as mentioned by Anon (1966) then subjected to GLC analysis using a Pye-unicam series 304 gas chromatography with flame ionization detector under the following conditions:

Column: PEGA 10% (polyethylene glycol adipate) Gas carrier nitrogen 30 ml/min. Inject. temp. 250 °C chart speed 1 cm/2 min. Detect. temp. 300 °C Column temp. 160 °C. Standard fatty acid methyl esters of the above mentioned fatty acids were used as standard authentic samples. The amount of each individual fatty acid was determined according to Nelson et al., (1969).

Hydrocarbons and sterols were determined by GLC with the same equipment. Quantitative identification was carried out by comparing the relative retention time with the standard outhentic samples. The quantitative analysis was carried out on the basis of peak area measurments.

Crude protein (N x 5.7), ash and pigments (carotenoids) were determined using the A.O.A.C (1980) methods. Phytate phosphorous was determined according to Lopez et al. (1983). Carbohydrates were determined enzymatically as

reported by Kerr et al., (1951), and tochopherols were determined according to A.O.A.C. (1977).

Quantitative determination of the total amino acids were carried out according to Moore et al., (1958) using Bechman amino acid analyzer. Essential amino acid index (EAAI) was calculated as follows using egg as reference pattern (FAO, 1970).

$$EAAI = \frac{\text{essential amino acids}}{\text{essential amino acid of Egg (47.07)}} \times 100$$

Cookie making:

Wheat germ was processed by heat treatment for 1 hr. at 100 °C (toasted) to improve its shelf life (Kent, 1983), and mixed with wheat flour in the ratios of 5, 10 and 15 %. The rheological properties of the different dough samples were carried out using a farinograph and extensograph tests according to A.A.C.C. (1962) methods. Baking test was carried out using A.A.C.C. (1969) method. Organoleptic evaluation of the cookies was carried out as described by Samir et al., (1977).

RESULTS AND DISCUSSION

Results concerning the chemical composition of white and red wheat germ are shown in Table (1). The obtained results indicate that red wheat germ has higher crude protein, ash, phytate phosphorous and carotenoids content than white wheat germ. Lipids content were 8.3 and 7.9 % with tochopherols content of 0.027 and 0.028 % for both white and red wheat germ respectively. However, close ratios to those obtained herein for lipids and tochopherols content were reported by Schild (1983).

Results of fatty acid GLC analysis presented in Table (2) indicate the presence of the three saturated fatty acids; lauric, Myristic and Palmitic in both wheat germ oil. Also, stearic was found in small quantity in white wheat germ oil. Unsaturated fatty acids were identified as oleic, linoleic and linolenic acids in both varieties inaddition to small quantity of unknown fatty acid in white wheat germ oil. Similar ratios for fatty acids was obtained by Kent (1975) from his study on wheat germ.

Table (1): Chemical composition of white and red wheat germ.

Chemical composition		Germ variety	
		White	Red
Lipids	%	8.30	7.90
Unsaponifiable	%	3.10	3.00
Protein	%	18.38	25.81
Ash	%	3.82	4.46
Carbohydrates	%	46.16	41.15
Phytate phosphrous	%	1.42	1.89
Tocopherols	%	0.027	0.028
Carotenoids	ppm	11.50	13.82

Table (2): Fatty acid composition of white and red wheat germ.

Fatty acid		Wheat germ fatty acid %	
		White	Red
Lauric	C12:0	0.11	0.63
Myristic	C12:0	0.18	0.08
Palmitic	C16:0	20.33	13.64
Stearic	C18:0	0.34	-
Oleic	C18:1	15.14	20.34
Linoleic	C18:2	56.99	55.92
Linolenic	C18:3	6.25	9.35
Unknown	----	0.65	-
Total saturated acids		20.96	14.35
Total unsaturated acids		79.03	85.61

The amounts of saturated and unsaturated fatty acids differ to a little extent according to wheat germ variety. The saturated fatty acids represented 20.96 and 14.35 % ; while the unsaturated acids were 79.03 and 85.61 % for white and red wheat germ oil respectively.

It is clear that palmitic acid represented the highest percentage of saturated fatty acid in the extracted oil (20.33 and 13.64 %) while linoleic was the predominant fatty acid (56.99 and 55.92 %).

Unsaponifiable matter content of wheat germ oil:

Results concerning the unsaponifiable matter and the relative retention time (RRT) of the standard authentic hydrocarbons and sterols are shown in Table (3). The data show the presence of 16 saturated and unsaturated hydrocarbons and 4 sterols varied in their retention time. The relative retention time (RRT) of the hydrocarbons and sterols was calculated in relative to B-sitosterol. The different fractions were identified by comparing their RRT with those of the authentic samples under the same conditions. Seven hydrocarbons were identified as C_{21}, C_{23}, C_{24}, C_{25}, C_{26}, C_{28}, and C_{30}, while the others are unknown. The hydrocarbons content was 72.85 and 82.27 % and, C_{28} was the most abundant hydrocarbon (60.23 and 58.93) in the two varieties under study. Four sterols were identified two as campsterol and B-sitosterol with RRT of 0.84 and 1.00 and two unknown sterols (with RRT of 1.13 and 1.34). Sterols content was higher in white germ oil (27.05 %) than in the red wheat germ oil (16.32 %). This could be attributed to varietal characteristics. The ratio of total hydrocarbons to total sterols were 2.69 : 1 and 5.03 : 1 for white and red wheat germ oil, respectively. The obtained data show that the unsaponifiable matter of white and red wheat germ oil varieties are differ from each other in the ratios of their unsaponifiable matter composition.

Amino acid composition:

The amino acid composition of defatted wheat germ (white and red varieties) are present in Table (4), the data indicate that glutamic, proline, phenylalanine and asparatic acids are the most abundant amino acids in the two varieties. The first limiting amino acids are cysteine and methionine (sulphur containing amino acids). Cystiene is present in minute quantities (0.11 and 0.08 g/100 g protein). White and red wheat germ varieties contain high quantities of lysine (5.25 and 4.64 g/100 g protein) and

Table (3): Unsaponifiable matter content (%) of white and red wheat germ oil.

Component	R.R.T.*	Content	
		White	Red
Unknown	0.04	0.68	0.59
n_hencosane C21	0.05	0.19	0.37
n_tricosane C23	0.07	0.19	0.95
n_tetracosane C24	0.08	0.03	1.27
n_pentacosane C25	0.10	0.29	1.93
n_hexacosane C26	0.11	0.54	4.51
Unknown	0.14	0.46	3.29
n_octacosane C28	0.18	60.23	58.93
Unknown	0.22	0.72	1.16
Squalene	0.26	0.34	0.44
Unknown	0.30	0.53	0.76
Unknown	0.33	1.47	0.46
Unknown	0.41	0.28	1.48
Unknown	0.46	1.59	5.06
Unknown	0.55	4.59	1.07
Unknown	0.62	0.72	-
Campsterol	0.84	2.65	4.40
B.sitosterol	1.00	5.48	9.59
Unknown	1.13	6.31	0.00
Unknown	1.34	12.61	2.33
Total hydrocarbons		72.85	82.27
Total sterols		27.05	16.32

* R.R.T. = Relative retention time

Table (4): Amino acids composition of white and red wheat germ varieties as gram / 100 gram protein.

Amino asids	Wheat germ varieties	
	White	Red
Essential amino asids:		
Lysine	5.25	4.64
Leucine	5.20	5.53
Isoleucine	4.14	3.49
Cysteine	0.11	0.08
Methionine	1.23	1.62
Phenylalanine	9.23	8.00
Tyrosine	2.70	2.95
Threonine	3.28	3.28
Valine	4.11	4.88
Total essential amino acids (E)	35.25	34.47
Non essential amino acids:		
Histidine	4.05	3.23
Arginine	5.28	5.60
Asparatic acid	8.79	7.07
Glutamic acid	14.55	16.46
Serine	4.20	4.16
Proline	10.01	10.25
Glycine	5.10	5.08
Alanine	4.63	5.00
Total non essential amino acids (N)	56.61	56.85
Total amino acids (T)	91.86	91.32
E/N: Ratio of essential amino acids to non essential amino acids.	62.27	60.63
E/T: Ratio of essential amino acids to total amino acids.	38.37	37.74
Essential amino acids index (EAAI)	74.89	73.23

adequate quantities of threonine i.e. 3.28 g/100 g protein. Since lysine is the first limiting essential amino acid in most cereal proteins (Tsen et al., 1974), addition of wheat germ to wheat or corn flour would certainly be very fruitful in fortifiering cookies and bread (bakeries). Total essential amino acids was some what higher in white wheat germ than in red wheat germ, while total non essential amino acids in both wheat germs were approximatly the same. Consequently, essential/non essential amino acids (E/N), essential/total amino acids (E/T) ratios as well as essential amino acid index (EAAI) were higher to some extent in white wheat germ than in red wheat germ.

Pheological properties: Different ratios (5, 10 and 15 %) of processed white wheat germ were added to wheat flour (72% extraction) and the rheological properties of the dough were examined.

Farinograph test: The results of this test are shown in Table (5).

Processed wheat germ addition weakend the dough. It reduced stability and valorimeter values. Meantime, water absorption and degree of softening were increased. Weakening of the dough could be attributed to gluten dilution and to wheat germ glutathaion content which activates dough proteases enzymes (Refai 1965 and Staudt and Ziegler, 1973).

Extensograph data (Table, 6) show that addition of wheat germ reduced the parameter values of the extensograph i.e. dough extensibility, resistance to extension, energy and proportion number of the mixtures. The observed reduction was in descending order with the percentage of the mixed wheat germ. It could be concluded that the rheological properties of the different mixtures caused dough weakening after wheat germ addition comparing with control (100 % wheat flour 72 % extraction rate). This weakening effect is due to wheat germ low gluten and high lipids contents (Jensens and Martens, 1983).

Data concerning cookie measurs i.e thickness, diameter, spread factor, volume, weight and specific volume for each cookie (calculated from the average of 6 cookies) are shown in Table (7). It is noticed that addition of 5 % wheat germ caused reduction in the measures of the produced cookie comparing with control cookie (100 % wheat flour). Increasing wheat germ up to 10 % improved the cookie measurs and the

Table (5): Farinograph parameters of flour and wheat germ mixtures.

Wheat germ addition %	Water absorption %	Dough development time min	Dough stability min	Weakening of the dough after 10 min B.U.	20 min B.U.	Valorimeter Value
Zero (Control)	53.7	1.00	6.00	70	110	41
5	54.5	1.50	2.75	100	140	34
10	55.2	1.50	3.00	120	160	33
15	56.7	1.75	3.50	120	180	30

Table (6): Extensograph parameters of flour and wheat germ mixtures.

Wheat germ addition %	Dough extensability mm	Resistance to extensability B.U.	Proportional number R/E	Energy area Cm2
Zero (Control)	127	535	4.13	76.5
5	130	270	2.07	39.3
10	103	200	1.94	20.7
15	90	190	2.11	18.3

Table (7): Cookie measurs and Organoleptic evaluation of the produced cookies.

Characters:			Wheat germ addition %			
			Zero control	5	10	15
Cookie measurs:						
Thickness	cm	(T)	0.91	0.83	0.91	0.87
Diameter	cm	(W)	5.00	4.80	5.35	4.80
Spread factor		W/T	5.49	5.78	5.88	5.51
Volume	cc	(Vol)	14.00	12.60	13.30	12.30
Weight	gm	(Wt)	6.32	5.69	5.94	6.22
Specific volume		Vol/Wt	2.21	2.21	2.23	1.98
Organoleptic evaluation:						
Appearance		10	9	8	9	7
Grain		10	9	8	8	7
Tender		10	9	8	8	7
Flavor		10	9	8	8	7
Total score		40	36	32	33	28

ratios of spread factor and specific volume/weight. However, 15 % wheat germ addition resulted in notable reduction in all cookie measurs.

Results of the organoleptic characteristics of wheat germ mixturs cookies (Table, 7) indicate that addition of 10 % wheat germ improved all cookie measurs comparing to 5 % germ addition as it improved diameter and spread factor comparing with control.

Therefore, it could be concluded that satisfactory cookie measurs and organoleptic characteristics could be obtained by mixing 10 % wheat germ with wheat flour for cookie production.

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استخدام جنين القمح فى انتاج البسكوت

ناديه يحيـــى أحمد عطيه

تمت دراسة التركيب الكيماوى لصنفى جنين القمح الابيض والاحمر وامكانيـــة خلط الجنيـن بدقيق القمح بنسب ٥ ، ١٠ ، ١٥ ٪ لإنتاج البسكوت وتأثير ذلك على الصفات الحســـيه وتقييم البسكوت الناتج.

أوضحت الدراسه أن جنين القمح الاحمر تميز بارتفاع نسبة البروتين الخام ، والرمـــاد والكاروتينات وانخفاض نسبة الزيت والكربوهيدرات مقارنه بجنين القمح الابيض .

كانت نسبة الاحماض الدهنيه الغير مشبعه مرتفعه فى الصنفين ٧٩٫٥٤ ، ٨٥٫٧٧٪ وكـان حمض اللينوليك هو الحمض الدهنى السائد. أيضا كانت نسبة الهيدروكربونات عاليـــة ٧٢٫٨٤ ، ٨٢٫٢٥٪ وكان C_{28} هو الهيدروكربون السائد بنسبة ٦٠٫٢٣ ، ٥٨٫٩٣٪ لكـــلا من الجنين الابيض والاحمر.

أوضحت نتائج تقدير الاحماض الامينية أن أحماض الجلوتاميـك والبرولين والفينيـــل الانين والاسبارتيك هى الاحماض الامينية السائدة وأن كل من الستين والميثونين يوجدا بكميات قليلة . كذلك فان صنفى جنين القمح يحتوى على نسبة عالية من حمض الليسين .

اضافة جنين القمح الى الدقيق أضعف صفات العجين وخفض من قيم أختيار الاكستنوجراف.

أمكن الحصول على بسكوت ذو صفات مقبولة باضافة جنين القمح الى الدقيـق العـــادى بنســـبه ١٠٪ .