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RHEOLOGICAL AND SENSORY EVALUATION OF SOME SNACKS MODIFIED TO IMPROVE THEIR NUTRITIVE AND HEALTH VALUE

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ABSTRACT

Snacks from the local market were modified, in order to raise their nutritional and health value. Some food sources known to be rich in either protein or health compounds were added to the original formula. These sources were skimmed milk, eggs, whey protein, wheat germ, chickpea, rice, soybean, carrot, orange peel or strawberry. It was necessary, therefore to assess the dough characteristics and as well as baking quality and sensory evaluation of the final product. The modified formulas were prepared in the form of biscuit and corn flakes. They contain higher protein content than the original, (13.65 – 17.77 % relative to 8.16 % for the original formula of biscuits). The diameter, spread ratio and weight of biscuit were decreased due to mixing wheat flour with skimmed milk and eggs. This decrease was more pronounced due to addition of each of chick pea and carrot, wheat germ and strawberry, rice and carrot and soy bean and orange peel. The height, volume and specific volume were, however increased. The maximum viscosity was markedly decreased in the formula containing chickpea and carrot. Addition of these food sources to the original formula did not appreciably affect the sensory properties of the final product.

It was concluded that, the modified formulas are characterized by the high protein content and compounds with health value that can provide consumers particularly children with protein and other compounds that protect them from health hazards. In the same time, these products keep on their rheological properties to a good extent and still have good sensory properties that make them acceptable by the consumer.

INTRODUCTION

Nutritious snacks play an important role in providing children with the energy and essential nutrients they need for healthy growth and development (Trumbo *et al.*, 2002). Not only children but also adults can benefit from snacks when they contain nutrients that can satisfy part of the physiological requirements.

Unfortunately most of snacks available in the market either local or foreign, although very attractive in packaging, taste and appearance, are very poor in nutritional value (El-Shobaki *et al.,* 2007)

The importance of snacks as part of the daily nourishing regimen for children or adults can not be ignored and in turn it is difficult to prevent consumer interest. Many companies, all over the world set up a regulation program in order to suggest healthier options and good nutrition lifestyle through developing more nutritious and healthy snacks (Gerber *et al.*, 2000). Although these snacks may have a lot of disadvantages such as being of low nutritional value and contain much calories from fat and carbohydrates, yet

they can be developed and contain nutritional elements of value to normal or special groups of the population as for children, pregnant, lactating and elder.

The value of nutritious snacks is not only to provide part of the nutritional needs of the consumer but also be preventive against diseases spreading among children as anemia and growth retardation. Not only this, but also obesity can be controlled by providing snacks that are of low caloric value.

A survey was done on the different types of snacks available in the local market, and the most suitable ones for development were selected. The nutritional value was improved through modifying the composition by addition of certain food sources of high nutritional value and rich in phytochemicals that proved to be healthy. Addition of new food sources to the original formula certainly affects the rheological, physical, and technological properties of the dough and the bakery product after wards (Doxastakis *et al.*, 2002; Dhingra & Jood, 2004, Srivastava *et al.*, 2007).

The present study aims to evaluate rheological properties of dough prepared from different proposed formulas and the sensory characteristics of the final product. This is to insure suitability for production and the acceptability of the consumers.

MATERIAL AND METHODS

Material

- Wheat flour (72% extraction) and wheat germ were purchased from the North Cairo Mills Company, Egypt.
- Skimmed milk, whey protein, sucrose, fat, baking powder, emulsifier, vanilla, eggs, honey, chick pea, rice, soy bean, carrot, strawberry, orange were purchased from the local market.

Preparation of samples.

Carrot, strawberry and orange peel were carefully washed with running tap water, then distilled water to remove any impurities. They were cut into small pieces with a clean knife, then spread on trays, dried in an air-drying oven regulated at 60ºC till complete dryness. Wheat germ was roasted in an air-drying oven regulated at 60ºC for one hour. Chick pea was soaked in distilled water for 9 hours, followed by cooking for 30 min., after that, peeled.

The dried samples were milled into a blender to fine powder, stored in polyethylene bags under cooling till used for the preparation of different formulas.

Preparation of flour blends

Wheat flour (72% extraction) was partially replaced by wheat germ, whey protein, chick pea, rice, soy bean, carrot, strawberry, orange peel to obtain flour mixtures used in manufacture of biscuits as shown in table (1), while corn flour gelatinized was used in manufacture of corn flakes.

Rheological properties

Rheological properties of doughs were evaluated using Farinograph (Model Type No: 81010 (31, 50 and 63 rpm), Brabender OHG, Duisburg, 1979 Germany) and Viscoamylograph ((Brabender amylograph, Duisburg Nr. 940053, type 680022) according to AACC (2000). Falling number test was carried out according to AACC (2000).

Preparation and evaluation of biscuits

The basic formula of biscuit was prepared from wheat flour, sugar, fat, salt and backing powder. This formula was modified by adding the different ingredients that are believed to raise the nutritive and health value of the biscuit as shown in table (1). These ingredients are: skimmed milk, eggs, whey protein, chick pea and Soy bean to raise the protein content. Carrot, orange peel, strawberry or wheat germ to raise the health value.

Biscuits (basic and modified formulas) were prepared by mixing wheat flour (72%) with other ingredients according to table (1). Then 14.7 ml of dextrose solution (5.93%) and the suitable amount of water were added according to AACC (2000). These formulas were baked in a special oven at 200 °C for about 15 minutes. Weight, volume, specific volume, diameter, thickness and spread ratio of biscuits were recorded. Organoliptic characteristics of biscuits were evaluated according to Zabik and Hoojjat (1984).

Table 1: Composition of mixtures used in manufacture of biscuits and corn flakes.

Ingredients	Basic formula	Modified Biscuits						Basic formula	Modified Corn flakes		
	1	2	3	4	5	6	7	1	2	3	4
Wheat flour 72%	100	100	85	75	80	83	86	--	--	--	--
Corn flour	--	--	--	--	--	--	--	50	50	50	50
Sucrose	50	15	15	15	15	15	15	1	5	5	5
Honey	--	--	3	3	3	3	3	--	1.5	1.5	1.5
Fat	28	20	20	20	20	20	20	--	--	--	--
Baking powder	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0
Salt	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5
Emulsifier	1.0	1.0	1.0	1.0	1.0	1.0	1.0	--	--	--	--
Skim milk	--	5	5	5	5	5	5	--	--	5	2.5
Eggs	--	20	20	20	20	20	20	--	--	--	--
Whey protein	--	--	10	--	--	--	--	--	5	--	2.5
Wheat germ	--	--	--	--	15	--	--	--	--	--	--
Chick pea	--	--	--	20	--	--	--	--	--	--	--
Rice	--	--	--	--	--	10	--	--	--	--	--
Soy bean	--	--	--	--	--	--	7	--	--	--	--
Carrot	--	--	--	5	--	7	--	--	5	5	2.5
Orange peel	--	--	5	--	--	--	7	--	--	--	2.5
Strawberry	--	--	--	--	5	--	--	--	--	--	--

Preparation and evaluation of Corn Flakes

Traditional or basic corn flakes were prepared from corn, sugar, salt and backing powder. This traditional formula was modified by preparation from whole gelatinized corn according to Hussein and Hegazy (2007) and adding the other ingredients namely, skimmed milk, whey protein, honey, carrot, orange peel or strawberry. The dough was prepared, cut into small pieces, spread into thin layers on a tray, cut into flakes then, placed into the oven at 250 °C for 4 minutes. Organoleptic characteristics of corn flakes were evaluated according to Zabik and Hoojjat (1984).

Gross chemical composition

The prepared biscuits and corn flaks were chemically analyzed for crude protein and fat according to methods described in AOAC (1990).

Color attributes

The color of different samples of biscuits and corn flaks was measured using a Spectro-Colorimeter (Tristimulus Color Machine) with CIF lab color scale (Hunter, Lab Scan XE, Germany).

Statistical analysis

Data of organoleptic evaluation of biscuits and corn flaks were subjected to analysis of variance and least significant difference (L.S.D) at 0.05 level according to the method described by McClave and Benson (1991).

RESULTS AND DISCUSSION

It is important, when any modification is made to any formula to see and investigate how such process affect the rheological properties of the dough and baking quality of the final product. Also, to insure that the sensory properties are still the same or even improved. To insure this, the physical and technological properties of the dough after adding the different food sources to the original formula were studied.

As shown in tables (2&3), the protein content of the modified formulas was markedly increased to values approximately double the basic formula, it ranged between 13.65 – 17.77% compared to a value of 8.16% for the basic formula of biscuits. This is particularly valuable specialty for poor children who are not able to obtain their physiological requirements from protein. Such value supplies the child with about 40% of his requirements when consuming 100 g of such food (National Research Council, 1980). In addition to this, such modified formulas contain considerable health compounds obtained from the different food sources added to the original formula. The added food sources such as whey protein contains sulpher amino acids as cysteine and methionine (Walzem *et al.*, 2002) and also contains branched chain amino acids (Anthony *et al.*, 2001). These amino acids are helpful to improve the body capacity to scavenge free radicals (Bounous & Gold, 1991), and protect against viruses (Wolber *et al.*, 2005), and alherosclerosis (Kawase et al., 2000). Wheat germ known to be rich in vitamin E, which act as potent antioxidant (Paranich et al., 2000), and contain essential fatty acids that are important to health (Scott *et al.*, 1998). Carrot rich in β-carotene and in turn a good source to vitamin A, with multiple health benefits to the body (Diplock, 1991 and Lomnitski *et al.*, 1993). Orange peel with its content of pectin, a fiber that is important to the proper function of colon and absorbs fat from the meal (Munakata *et al.*, 1995). Strawberry with it's high polyphenol content and subsequent health benefits (Meyers *et al.*, 2003). It is clear that these modified formulas almost are of high nutational and health values.

The nutritional and heath values of these products are however not enough when considered alone. It is necessary that these modified formula still possess suitable properties that makes them still keep on sensory qualities and rheological properties.

Table 2: Protein and ether extract of biscuits fortified with whey protein & orange peel (3), chick pea flour & carrot (4), wheat germ & strawberry (5), rice flour & carrot (6) and soy bean & orange peel (7).

Samples	Crude protein (gm)	Ether extract (gm)
1	8.16	26.12
2	14.62	21.83
3	15.96	22.71
4	17.36	24.12
5	16.86	22.12
6	13.65	22.76
7	17.77	22.19

Table 3: Protein and ether extract of corn flakes fortified with whey protein & carrot (2), skimmed milk & carrot (3), skimmed milk, whey protein, carrot & orange peel (4).

Samples	Crude protein(gm)	Ether extract(gm)
1	9.87	4.60
2	13.38	4.39
3	11.63	4.66
4	10.31	4.22

As shown in Tables (4, 5, and 6) the characteristics of dough and baking quality of biscuits were changed to varying degrees as a result of addition of various food supplements. As shown in Table (6), the weight, diameter and spread ratio of biscuit were decreased due to mixing wheat flour with skimmed milk and eggs. There were further decease of these values due to addition of each of whey protein & orange peel, chickpea & carrot, wheat germ & strawberry, rice & carrot, soybean & orange peel. The height, volume and specific volume were, however increased. The diameter or the spread ratio of cookies was reduced when wheat flour was mixed with non wheat supplements. Mc Watters (1978) stated that the rapid partitioning of free water to hydrophilic sites during mixing increased dough viscosity, thereby limiting cookies spread.

Table 4: Viscoamylograph parameters and Falling number of dough prepared from different formulas.

Samples	Temp.of transition (°C)	Max. of viscosity (BU)	Temp. of max. viscosity	Break down viscosity (BU)	Setback viscosity (BU)	Falling No. (Sec)
1	85.5	460	95	410	1050	76
2	81	590	95	485	1600	203
3	87	490	95	470	1080	89
4	87	130	95	130	470	94
5	75	380	95	380	790	84
6	64.5	550	95	470	1370	176
7	84	620	95	520	1310	188

Regarding the effect on viscosity, (table4), the maximum viscosity was markedly decreased in formula (4) containing chickpea and carrot. The

breakdown and setback viscosity of this formula were also markedly low. The values reported for the maximum of viscosity, breakdown viscosity and setback viscosity were 130, 130 and 470 BU respectively. All parameters of viscosity were increased in formula (2) that contains skimmed milk (5 gm) and eggs (20 gm). The relationships between composition and functionality of soft wheat flour components in relation to semi-sweet biscuit quality are limited (Fustier *et al.*, 2007). However, the increased viscoamylograph parameters due to addition of skimmed milk and egg are expected, due to the higher protein and in turn a semi-glutin network (Levine and Drew, 1994) and relatively more fat content.

Table 5: Farinograph parameters of dough prepared from different formulas.

Samples	Water absorption (%)	Arrival time(min)	Dough development time(min)	Stability time (min)	Weakning (BU)	Mixing tolerance index(BU)
1	61	1.75	9.0	13.0	110	40
2	58	2.5	10.0	11.5	80	30
3	62.5	3.5	10.0	17.0	110	20
4	61.5	2.0	6.5	10.0	140	25
5	56.5	2.0	7.0	12.0	100	30
6	52.3	1.1	7.0	14.0	160	30
7	58.5	1.0	9.0	18.0	90	15

Table 6: Baking quality of biscuits prepared from different formulas.

Samples	Diameter (cm)	Height(cm)	Spread ratio (diam./ht.)	Weight (g)	Volume (cc)	Specific volume (cc/g)
1	6.2	1.10	5.64	25.29	49.86	1.97
2	5.8	1.20	4.83	24.76	51.70	2.09
3	5.8	1.30	4.46	24.16	52.16	2.16
4	5.2	1.11	4.48	24.26	53.75	2.22
5	5.4	1.22	4.42	24.62	51.25	2.08
6	5.2	1.18	4.41	23.08	52.50	2.27
7	5.3	1.22	4.34	23.50	53.75	2.29

In this respect, it is worth mentioning that stress relaxation tests at high strain-values (Safari-Ardi and Phan-Thien, 1998) and creep recovery (Edwards and Dexter, 1999) could differentiate between dough from high protein and low protein wheat cultivars. The low values reported in formulas 4&5 containing chickpea and carrot or wheat germ and strawberry are most probably due to the change in partitioning of free water to hydrophilic sites affected by the added food source. The decreased viscosity of formula 4&5 is associated with relative increase in biscuit volume (Table 6). This may agree with the fact that decreased viscosity results in increased volume (Wang *et al.*, 2002; Ragaee and Abdel-Aal, 2006). However, the volume of other formulas with relatively higher viscosity also showed high volume. It seems

that the change in viscosity due to addition of these food supplements is not affecting the volume character. Water absorption was decreased in formula 6, containing rice & carrot, formula 5, containing wheat germ &strawberry (Table 5). This was associated with a decrease in development time and mixing tolerance index. Addition of soybean &orange peal caused a marked drop in weakening and mixing tolerance index. The results obtained by falling number test confirmed some readings those obtained by Viscoamylograph test.

The coloring characteristics (table 7), were more or less not markedly changed except for (a) character (redness to green) in most formulas and (L) lightness in formula 5. The ΔE value was not markedly changed.

Table 7: color quality of biscuits and corn flakes from different formulas.

Samples	Biscuits				Corn flakes			
	L	a	b	ΔE	L	a	b	ΔE
1	80.00	4.47	28.75	85.12	43.33	2.36	19.33	47.50
2	78.39	3.00	27.67	83.18	34.69	4.49	15.71	38.35
3	72.85	7.89	42.72	84.82	37.32	4.03	16.49	40.99
4	67.1	10.41	36.91	77.29	18.76	6.54	13.28	23.89
5	55.22	12.45	30.21	64.16	-	-	-	-
6	71.74	7.57	37.49	81.29	-	-	-	-
7	71.32	9.87	40.96	82.84	-	-	-	-

L= lightness (100= white; 0= black), a= redness (+100) to green (-80)
b= yellowness (70) to blue (-80), $\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$

As shown in tables 8&9, the sensory evaluation of the modified biscuit showed that the food sources added to the original formula did not affect the sensory parameters of the new product. This confirm that the modified formulas, beside being of high nutritive and health value still keep on these sensory value which makes them attractive and accepted by the consumer. It is worth mentioning that most of the observations reported for biscuit formulas were also noted for corn flakes composed of similar ingredients.

Table 8: Statistical analysis of sensory properties of biscuits prepared from different formulas.

Samples	Color (10)	Flavor (10)	Taste (10)	Texture (10)	Appearance (10)	Overall acceptability (10)
1	7.9±0.57	8.15±0.58	8.1 ± 0.57	8.3 ± 0.95	8.3±0.63	8.0±0.77
2	7.9±0.75	8.0±0.03	8.1 ± 0.99	8.0 ± 0.94	7.9±0.88	8.2±1.03
3	7.9±1.60	7.7±0.95	7.9 ±1.22	7.5 ± 0.71	8.2±1.25	8.1±0.79
4	7.3±0.95	7.7±0.67	6.8±0.92	7.8 ± 0.63	8.1±0.76	7.8±0.92
5	7.9±1.00	8.2±0.79	7.3±0.67	8.0 ± 0.67	7.9±0.88	7.9±1.30
6	7.9±0.99	8.2±0.82	7.8±0.63	7.7 ± 0.82	8.0±0.67	8.4±0.97
7	7.9±0.74	8.4±0.75	7.9±0.57	8.4 ± 0.75	7.9±0.60	7.9±0.70
LSD at 0.05	Ns	Ns	Ns	Ns	Ns	Ns

Table 9: Statistical analysis of sensory attributes of corn flaks prepared from different formulas.

Samples	Color (10)	Odor (10)	Taste (10)	Texture (10)	Crispness (10)	Appearance (10)	Overall acceptability (10)	Total score (70)
1	8.65 [b]	8.45 [b]	8.80 [ab]	8.80	8.80	8.80	7.90 [b]	60.2
2	9.50 [a]	8.90 [ab]	9.10 [a]	8.80	8.80	8.40	8.80 [a]	62.3
3	9.60 [a]	9.25 [a]	9.35 [a]	8.20	8.20	8.60	8.70 [a]	61.9
4	9.35 [ab]	9.35 [a]	8.51 [b]	8.90	8.11	8.90	9.00 [a]	62.31
LSD at 0.05	0.95	0.91	0.83	Ns	Ns	Ns	0.63	

In conclusion, this study succeeded to develop a new product from snacks available in the local market characterized by being of high nutritional and health value. This was achieved through addition of natural food sources proved to contain good quantity of nutrients and health compounds. The new products are still suitable for industrial production and keep on its sensory characteristics and attractability. This is assumed to participate in improving the health state of children.

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تقييم الصفات الريولوجية والحسية لبعض المنتجات الغذائية المعدلة لرفع قيمتها الغذائية والصحية

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**** قسم علوم الأطعمة والتغذية– المركز القومي للبحوث - الدقي- مصر**

تم تطوير مجموعة من الأطعمة المنتشرة في السوق المحلية والمعروفة باسم ال snacks وذلك بهدف رفع القيمة الغذائية والصحية لهذه المنتجات عن طريق إضافة مجموعة من المصادر الغذائية المعروفة بارتفاع قيمتها الغذائية وفوائدها الصحية إلي المكونات الأساسية لهذه الأطعمة٠ هذه المصادر الغذائية التي أضيفت هي اللبن المجفف، البيض، بروتينات الشرش، جنين القمح، الحمص، الأرز، فول الصويا، الجزر، قشر البرتقال أو الفراولة٠

وحيث أنه من المتوقع أن هذه الإضافات يمكن أن تحدث تغييراً في الصفات الريولوجية للعجائن وكذلك في الصفات التكنولوجية والحسية للمنتجات المتطورة ولذلك فكان لزاماً أن يتم تقييم هذه الصفات للتأكد من صلاحية هذه الإضافات لعمليات التصنيع والقبول لدي المستهلك٠ هذا وقد أعدت المنتجات المطورة في صورة بسكويت وكورن فليكس٠ أكدت النتائج المتحصل عليها أن معظم المنتجات المطورة تحتوي علي نسبة أعلي من البروتينات حيث كانت هذه النسبة تتراوح بين ١٣,٦٥% إلي ١٧,٧٧% مقارنة بنسبة ٨,١٦% في المنتج الاصلي٠ حدث انخفاض في قيم بعض المدلولات الريولوجية مثل درجة حرارة التحول، نسبة إمتصاص الماء و زمن الوصول ومعدل الصمود في حين حدث زيادة في اللزوجة القصوى واللزوجة أثناء التبريد ورقم السقوط ودرجة الثبات للعجين ٠ أوضحت اختبارات جودة الخبيز حدوث نقص في القطر،معدل الفرد، الوزن واللون في حين زاد الحجم والإرتفاع والوزن النوعي للبسكويت نتيجة إضافة بعض المصادر الغذائية إلي الدقيق وخاصة اللبن المجفف والبيض٠ وقد وضح هذا الانخفاض في حالة إضافة الحمص والجزر أو جنين القمح والفراولة المجففة أو الأرز مع الجزر المجفف أو فول الصويا مع قشر البرتقال المجفف. أوضحت الاختبارات الحسية لهذه الإضافات أن المنتج المطور مازال محتفظاً بكثير من الصفات الحسية التي تجعله مقبولاً ومستساغاً لدي المستهلك.

إجمالاً يمكن أن نخلص من هذه الدراسة إلي أنه يمكن تطوير الكثير من الأطعمة الشائعة في السوق المحلي والتي يستهلكها قطاع كبير من الناس خاصة الأطفال وجعلها أفضل من حيث القيمة الغذائية بالإضافة إلي احتواءها علي مركبات صحية تحمي من الإصابة بالأمراض محتفظة بجودتها التصنيعية والحسية .