CHEMICAL AND TECHNOLOGICAL STUDIES OF MANGO SEED KERNEL

Asma Ahmed Easa Elgindy

College of Education, Najran University, P.O .Box (1988) KSA

ABSTRACT: *The present study aimed to benefit from the flour of mango kernels in the preparation of biscuits after some industrial processing operations to reduce kernels' content of tannins. Nutritional value of the flour of mango kernels and wheat and prepared biscuits by replacing 10%, 20%, 30%, 40% and 50% of wheat flour by the flour of mango kernels. Results showed that the content of the flour of mango kernels of raw fat was 12.39% and the ratio of unsaturated fatty acids was 55.3%. Results also revealed that by increasing replacement proportion the content of biscuits of fibers, ash and fats increased while its content of proteins and carbohydrates decreased. Sensory properties of biscuits also improved by increasing the replacement proportion until 40%. Thus, the results confirm that the use of the flour of mango kernels as an alternative for wheat flour, with 40% of replacement, in the preparation of biscuits improves the nutritional value and quality of biscuits.*

KEYWORDS: Mango flour**,** mango kernel, biscuits preparation, Najran University

INTRODUCTION

Mango (*Magnifera indica*) is a perennial crop of the family Anacardiacea. It is grown practically all over tropical and sub-tropical regions of the world. The fruits are oval or kidney shaped with smooth, leathery skin and the color ranges from light or dark green to clear yellow when ripe. The pulp of the fruit is consumed fresh as a dessert or processed in to juices, jams and other products (Morton, 1987) while the seeds are discarded which often results in environmental pollution. Kordylas (1990) has however reported that the seeds have been used in compounding animal feed. The edible part (the pulp) contains 85% water, 0.9% fiber, 0.5% ash, 0.2% fat and15.8 percentage carbohydrate (Elegbede *et. al.*, 1995). Mango seed is a single flat oblong seed that can be fibrous or hairy on the surface, depending on the cultivar. Inside the seed coat 1 - 2 mm thick is a thin lining covering a single embryo, 4 - 7 cm long, 3 - 4 cm wide, and 1 cm thick. Mango seed consists of a tenacious coat enclosing the kernel. The seed content of different varieties of mangoes ranges from 9% to 23% of the fruit weight (Palaniswamy et. al., 1974) and the kernel content of the seed ranges from 45.7% to 72.8% (Hemavathy et. al., 1988). It has been reported that the seed kernel contains 44.0% moisture, 6.0% protein, 12.8% fat, 32.8% carbohydrates and 2.0% ash (Elegbede et. al., 1995). However, Morton (1987) reported that the seed flour contains 5.56% protein, 16.17% fat, 0.35% ash and 69.2% carbohydrates. Little information exists on the ant nutritional and functional properties of mango seed flour. Knowledge of toxic substances naturally present in plants that are or may be used as food is useful in several ways because they affect the overall nutritional value of the food (Osagie, 1998). Functional properties are also very important as they determine the level of utilization in ingredient formulation and food product development (Tasneem *et. al.*, 1982). El- Bastawesy, et. al. (2007) revealed that, mango seed had high content of oil (21.85% on dry basis) and the chemical properties of this oil was in the normal range of edible oil. Youssef, (1999) indicated that, adding 1% of crude oil extracted from mango seed kernel exhibited antioxidant potency similar to that of 200 ppm of BHT against oxidation of sunflower oil (Maisuthisakul and Gordon, 2009) indicated that mango seed kernel has potent antioxidant activity with relatively high phenolic contents. Mango seed kernel was also shown to contain stigmasterol and tocopherols. The antioxidant effect of the mango seed kernel is due to high content of polyphenols, sesquiterpenoids and tocopherols. It is also rich in phytosterols and microelements like selenium, copper and zinc (Schiber et. al., 2003 & Nunez-Selles, 2005).

Therefore, this work is aimed to investigate the physical and chemical properties, of flour and oil composition in mango seed and effects of its implementation at different levels in baking performance and quality of the products

MATERIALS AND METHODS

Materials

Materials: Ripe mango seeds as by-products (waste) was collected after mango pulp processing from zebda variety during the summer season of 2016 from Al Rabie Saudi food CO. LTD. Commercial soft wheat flour (72% extraction), bakery fat, powdered sugar and skimmed milk powder were purchased from the local market. Food grade dextrose, sodium chloride, sodium bicarbonate and ammonium bicarbonate were used in biscuit processing. Sodium carbonate was obtained from El-Gomhoreya Co., Cairo, Egypt.

Preparation of Mango Kernel flour

Mango stones were cleaned and washed twice with tap water, then left to dry in the air. After the stones were individually hammered to obtain the kernels of which the outer cover was removed by hand after kernels were soaked in sulphited tap water at 50 °C for 48 h followed by autoclaving for 30 min at 121 °C (for reduce tannins) and dried by tray drier at 23 °C According (Legesse and Admassu, 2012). The dried material was ground in a hammer mill into a powdery form and kept in a closed dark glass bottle and stored at 4 °C until further analysis

Analytical Methods

Moisture, total protein, ether extract, total ash, crude fiber and minerals were determined according to methods in the A.O.A.C., (2000). Total carbohydrates were calculated by difference.

Preparation of the fatty materials to methylation

The methyl esters of mango kernel oil were prepared using benzene: methanol: concentrated sulfuric acid (10:86:4). Methylation was carried out at 70°c for 24 hrs according to the method described by *Ludy et al., (1968).*

Determination of the fatty acid methyl esters

Gas-liquid chromatography (Pye-unicam PRO-GC) was used for fractionation and determination of fatty acid methyl esters according to the method described by Zygadlo et al., (1994)

Blend formulation and biscuit processing

Blends of wheat and mango kernel flours for biscuit formulations were prepared and are shown in Table 1. Biscuit samples were processed from dough's containing 10, 20, 30, 40 and 50 % MKF as substituting levels for wheat flour according to a commercial formulation and baking practice of Kality Food Share Company. Biscuit dough was formulated by blending wheat flour, mango kernel flour with other ingredients. The formulated blends were mixed for 15 min at 125rpm (speed 2) using a mixer (type DITO - SAMA, Aubusson, France, 1997). Each batches of the dough were removed from the mixer and allowed to rest for 10 min. The dough pieces were sheeted and flattened using roller into a sheet of about 8 mm thickness, and then cut into rectangular pieces with size, 75 mm × 75 mm. Samples were baked in an electric oven at 249 oC for 18 min. After baking, biscuits were left to cool at room temperature and were wrapped tightly with polypropylene pouches and kept until further analyses took place

Blending processes were conducted by substituting specified proportions of (10%, 20%,30%,40% and 50%) mango kernel flour from the total percent of wheat flour (100%), and biscuits were made with these blending ratios using a similar procedure and ingredients as indicated in Table 1.

Table 1: **Formulation of dough containing mango kernel flour for biscuit development**

Ingredients					Biscuit dough formulation	
	Control	$MKWF_1$	$MKWF_2$	$MKWF_3$	$MKWF_4$	$MKWF_5$
Wheat flour (g)	1000	900	800	700	600	500
Mango kernel flour (g)	0.0	100	200	300	400	500
Sugar (g)	195	195	195	195	195	195
Margarine (g)	50	50	50	50	50	50
Milk powder (g)	2.5	2.5	2.5	2.5	2.5	2.5
Ammonium bicarbonate (g)	15	15	15	15	15	15
Sodium metabisulphite (g)	0.1	0.1	0.1	0.1	0.1	0.1
Water (ml)	*325*	*325*	*325*	*325*	*325*	*325*
Salt (g)	3	3	3	3	3	3
Vanilla (ml)	1.2	1.2	1.2	1.2	1.2	1.2

Where: WF- wheat flour, MKWF1- 10% mango kerne flour, MKWF2 - 20% mango kernel Flour- MKWF3 -30% mango kernel flour- MKWF4 -40% mango kernel flour – MKWF5 -50% mango kernel flour - as substituting levels for wheat flour

Evaluation of Biscuits

Physical Measurements: Diameter (W) of biscuits was measured by laying six biscuits edge-to-edge with the help of a scale. The same set of biscuits was rotated 90° and the diameter was remeasured. Average values were reported in millimeter. Thickness (T) of biscuits was measured by stacking six biscuits on top of one another and taking the average in millimeter. The spread ratio was calculated by dividing diameter (W) by thickness (T).

Sensory evaluation

Sensory evaluation was carried out for formulations mango flour and control. Taste, odor, color texture and the overall acceptability were evaluated according to Lanza, et. al., (1995).

Statistical analysis

Statistical analysis was applied to sensory and biological evaluation of adding different percentages from treated kernels flour. Data were treated to be for complete randomization design. Least significant difference (L.S.D.) was calculated at 1% level as significance. This analysis was carried out as mentioned by Snedecor & Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition of raw materials

Table 2: Chemical composition (on dry weight bases) of mango seed kernel and Wheat flour (72% ext.)

Macronutrients (%)	Wheat flour (72% ext.)	Mango seed kernel
	%	%
Crude protein	10.15±0.06	5.95±0.10
Crude oil	0.96±0.02	11.54±0.12
Total ash	0.53.±0.0 2	2.61±0.03
Crude fiber	0.45±0.02	2.32±0.01
Carbohydrate	87.91±0.61	76.73±1.20
Macro minerals mg/g		
Ca (mg/100g	95.12 ±0.02	40.35±2.30
Mg (mg/100g	56.02±0.5	172.23±5.54
Na (mg/100g)	11.32±11.3	306.35±7.34
K (mg/100g)	443.25±13.2	750.21±6.32
Micro minerals mg/g		
Copper	0.23±0.01	.51±0.01
Fe (mg/100g)	1.49±0.03	.76±0.02
Zn (mg/100g)	1.46±0.02	4.61±0.10

Data in Table (2) Show that the chemical composition of mango kernels were 5.95, 11.54, 2.32, 2.61 and 76.73 for crude protein, crude oil, crude fiber, total ash and Total carbohydrates respectively, also that mineral content of mango kernels proved to be a good source for some minerals such as Ca, Mg, K, Na, Fe and Zn.

Table 3: Fatty acid composition of mango seed kernel lipid

Fatty acid	Lipid fractions (% of total fatty acids) (Mean ± SD)
Myristic C14:0	0.9 ± 0.1
Palmitic C16:0	5.4 ± 0.2
Stearic C18:0	37.8 ± 1.1
Oleic C18:1	45.1 ± 1.9
Linoleic C18:2	8.8 ± 0.5
Linolenic C18:3	1.4 ± 0.3
Saturated fatty acids	44.1 ± 1.3
Unsaturated fatty acids	55.3 ± 0.5

The fatty acid composition of of mango kernels oil is pre-sented in Table (3). The results revealed that saturated fatty acid being 44.1% and the unsaturated fatty acids (55.3 %), ratio of unsaturated to saturated fatty acids was 1.25. This ratio indicated that mango kernels oil is moderate stable to oxidation as mentioned by Hemavathy, et. al. (1987). Stearic acid was the main saturated fatty acid (37.8%), while oleic acid was the major unsaturated one (45.1%). On the other hand, linolenic acid was found in less amount (1.4 %).Accordingly, mango kernels oil is more stable than many other vegetable oils rich in polyunsaturated fatty acids. Such mango kernels oil to be suitable for blending with vegetable oils, stearin manufacturing, and confectionery and in the soap industries. These results confirmed those of Abdalla, et. al. (2007) and Nzikou, et. al. (2010).

Table 4: Chemical composition (dry weight bases) of biscuit replaced by different levels of mango seed kernel flour

Macronutrients (%)	Control	Types of Biscuit				
		MKWF1	MKWF2	MKWF3	MKWF4	MKWF5
Moisture	12.92± 0.11	12.69±0.22	12.53± 0.37	12.40±0.22	12.32±0..32	12.11±0.28
Protein	10.02±0.01	9.88±0.08	9.46±0..11	9.03±.05	8.89±.09	8.75±.012
Fat	1.54±0.22	2.31±0.11	3.09±0.14	3.71±0.61	4.31±0.35	4.65±0.15
Ash	0.81±0.03	1.11±0.02	1.21±0.02	1.29±0.01	1.35±0.02	1.41±0.03
Fiber	0.71±0.01	0.92±002.	1.16±0.01	1.35±0.03	1.51±0.02	1.75±0.01
Carbohydrate	73.97±0.42	73.09±	72.55±0.89	72.22±0.07	71.62±0.17	71.33±0.31
Energy (kcal)	349.82±0.31	352.67±0.4	355.85±0.29	358.4± 0.5	360.83±0.19	362.17±0.21

Table (4) shows the chemical composition of biscuit and the effect of adding mango kernels flour on the chemical composition of biscuit. From these data, it could be noticed that fat, fiber and ash contents tended to increase by increasing the level of added mango kernels flour. On the contrary, total carbohydrates and protein tended to decrease with increasing the supplementation level.

Table 5: Physical properties of biscuit replaced by different levels of mango seed kernel flour

Attribute	Control	Types of Biscuit				
		MKWF1	MKWF2	MKWF3	MKWF4	MKWF5
Diameter(mm)	51.34±1.5	52.30± 1.20	53.79 ±1.12	53.91±1.6	54.51±1.2	54.73±1,26
Thickness(mm	9.57± 0.02	9.55± 0.02	9.25± 0.07	9.15± 0.05	8.80±0.02	8.70± 0.10
Spread ratio%	5.36±.3	5.47±.5	5.82±.4	5.89±.2	6.19±.6	6.3±.7

The physical measurements of biscuits are provided in Table 5. The spread ratio%, Diameter(mm) and Thickness(mm) values of biscuits and control sample were ranged from 6.38 to 5.63, 54.73 to 51.34, and 9.57 to 8.70; respectively

Physical Measurements of Biscuits: The effect of replacing 10, 20, 30, 40 and 50% of wheat flour with MKF on physical properties of biscuits was studied and the data are presented in Table 5. The results showed that all selected MKF treatments caused increase in biscuit diameter as compared with 51.34 mm for control. The highest diameter (54.73 mm) was found by MKF at 50%. It was also clear that using d MKF at all levels in biscuit preparations resulted decrease in thickness when compared with 9.57 mm for control.

Concerning the spread ratio, it was observed that replacing of 50% wheat flour by MKF recorded the highest value 6.3 compared with 5.36±.3 mm for control. This result agrees with the results by (Ashoush and Gadallah, 2011)

Table 6: Sensory Evaluation of of biscuit replaced by different levels of mango kernel flour

Attribute	Control	Types of Biscuit					LSD
		MKWF1	MKWF2	MKWF3	MKWF4	MKWF5	
Appearance (10)	7.5±.5	7.5±.4	8.5±.5	8.5±.5	9.5±.5	7.1±.4	0.80
Color (10)	7±.5	8±.4	8±.5	9.6±.4	9.6±.4	7,3±.6	0.60
Taste (10)	7.6±.3	8.2±.4	8±.5	9±.3	9.5±.4	7.5±.5	0.70
Flavor (10)	7.5±.4	8.5±.2	8.5±.5	8.8±.4	9±.3	7.4±.4	0.80
Texture (10)	7.5±.3	8.0±.4	8.6±.3	9±.2	9±.3	7.1±.4	0.70
Overall acceptability(50)	37.6±.3	40.2±.3	42.6±.4	45.4±.5	47.2±.4	36.4±.2	0.90

The sensory evaluation was carried out to define the best formula being acceptable among other ones. The measured sensory characteristics included color, texture, taste, odor and overall acceptability. The results and statistical analysis in table (6) indicate Sensory evaluation studies showed that the surface color and appearance of biscuits containing up to 40% of MKF were as acceptable as those of control biscuits were. Results also showed that biscuits had acceptable texture with increased levels of MKF up to 40% as compared to the control. The taste and flavor of biscuits were improved with incorporation of MKF as these biscuits had typical pleasant mango flavor. Regarding to overall quality, it could be observed that biscuits incorporated with MKF up to 40% showed higher scores compared to control.. It could be concluded that biscuits with acceptable overall quality can be prepared by substituted 40% of wheat flour with MKF, this result in harmony with those by (Aziah & Komathi, 2009).

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