UTILIZATION OF MANGO KERNELS FLOUR IN THE IMPROVEMENT OF BAKERY PRODUCTS

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Abstract

The present study was to utilize mango kernels wastes for improving some bakery products which could be analyzed for Physico-chemical, biological, bacteriological and rheological characteristics. Soaking in 1% NaCl solution was carried out to get rid of toxic compounds such as amygdaline hydrocyanic acid and trypsin inhibitors . These treatments caused slight reduction of crude protein and total carbohydrates. This aforementioned treatment caused increasing in acid value and peroxide value as well as decreasing in unsaponification matter . Oil content and fatty acid composition weren't affected by this treatment. Bakery products supplemented with mango kernels flour contained the highest value of protein, oil, fiber and ash while it contained the lowest value of total carbohydrates. Supplementation of wheat flour by using mango kernels flour promoted rheological properties. The shelf life of the produced cake increased for 8 days at room temperature and for 28 days with cold storage. Statistical analysis results indicated no significant differences between the control sample and supplemented bakery products. Gain in the rat body weight in the final nutritional period increased by increasing the mango kernels flour addition.

INTRODUCTION

Mangoes *(Mangifera Indica L)* are considered among the most popular fruits grown in Egypt. The average total annual areas cultivated with mangoes are about 68356 feddans producing about 230873 tons of fruits. Mango kernels represent about 24% of the weight of the whole fruits. There are need to convert these refuse materials into available by products. Food researches interested in supplementing bakery products by mango kernels flour and many other dairy by – products rich in protein as a mean of lessening the malnutrition of animal protein and as a good source of protein. The current work is aiming to utilize mango kernels flour in the improvement of bakery products as well as enhance both nutritive value and microbiological quality to extend the shelf – life of the product. Mango kernels depend on the variety contains an average of 5.89% protein, 12.32% fat, 77.03% carbohydrates, 2.49% crude fibers and 2.27% ash *(Atwa et. al., 2008).* Mango kernel powder was used as an antioxidant agent for ghee. Its effect could be attributed to

the phenolic compounds and also to the presence of phospholipids that helped to prolong the shelf life of stored ghee *(Mona et. al., 2006).* The total antioxidant capacity and phenolic content of edible portions and seeds of mango were studied by *Soong and Barlow, (2004).* Several studies had been carried out concerning the toxic compound removal from these kernels to be used as a food and feeding source, *(Solis and Duran, 2004).* The aim of the present work was to study the Physico - chemical, biological and rheological characteristics of mango kernel and its flour in the improvement of bakery products.

MATERIALS AND METHODS

Materials:

Representative samples of mangoes *(Mangifera Indica L.)*, namely Balady, were obtained from juice extraction unit of the pilot plant of the Food Technology Research Institute, Agric. Res. Center, Giza, Egypt. These wastes were dried at 40·c in a drying oven, and then stored at room temperature (25 ± 2 ·c) for further uses.

Methods:

Preparation of mango kernels samples:

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 soaking in 1% of NaCl solution for 12 hrs. at room temperature. Then dehydrated under vacuum for 2 hrs. to remove most of the water and the water residue was further eliminated by dehydration at 105·c for 2 hrs..

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.

Physico - chemical characteristics:

These include refractive index, acid and peroxide values, iodine value, saponification value, melting point, unsaponification matter which were determined according to the method described in the *A.O.A.C. (2000).*

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).*

Nutritional quality:

Amygdaline:

Determination of the amygdaline content (as hydrocyanic acid) in mango kernels (Amygdaline = HCN x 16.9257).Hydrocyanic acid was extracted from mango kernels samples according to the method reported by *Cruess, (1958)* while hydrocyanic acid content (raw and during the soaking stage) was determined according to the method described by *the A.O.A.C., (2000).*

Tannins:

Tannins were determined colorimetrically as described in *A.O.A.C., (2000).*

Phytic acid:

Phytic acid was determined according to the method of Wheeler and Ferrel, (1971).

Trypsin inhibitor:

Trypsin inhibitor was determined according to the method of Roy and Reo, (1971).

Utilization of mango flour in bakery products:

The mango flour was blended with the soft wheat flour in making sponge cake batter at levels of 15, 25 and 35 % (w/w) of the wheat flour according to Nagao et. al., (1976) with some modifications The cake batter was baked in an automatic laboratory bakery oven at 180 C, then cooled and packaged in polyethylene.

Rheological properties:

Rheological characteristics of the resultant dough under investigation were determined according to the method described in A.A.C.C, (1990).

Sensory evaluation:

Sensory evaluation was carried out for formulations mango flour in NaCl solution 1 % (T) 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 and Cochran (1980).*

Bacteriological evaluation:

Total viable and fungi counts were enumerated as c.f.u./gm of the produced cakes at zero time and during the different intervals of both room temperature and cold storage according to the methods of (*Leo, 1982*) using the nutrient agar and malt extract agar media according to (*Difco,1986*).

Biological tests using rats:

Male albino rats average weight 80-89g. were obtained from the Research Institute of Ophthalmology, Giza, Egypt.

The biological assays were carried out to determine the gain in weight of rats for best meals. The effects of adding different percentage from treated mango kernels flour were biologically evaluated. The salt and vitamin mixture used in these experiments were as recommended by *A.O. A.C, (2000).* Test rats were kept out under normal healthy conditions and fed on basal diet for one week. The test animal includes 5 groups each of 6 rats for each diet (basal diet as control (+) and control (-) protein free diet and fed for 8 weeks.

RESULTS AND DISCUSSION

Chemical composition of raw materials:

Data in Table (1) Show that the chemical composition of mango kernels were 5.93, 12.39, 2.51, 2.37 and 76.80 for crude protein, crude oil, crude fiber, total ash and Total carbohydrates respectively. Soaking in 1% NaCl solution caused the decrement of crude protein and total carbohydrates, while slightly increment of crude oil . These results are in agreement with the findings of *Radi (2005).*

Table 1. Effect of soaking in 1% NaCl solution on chemical composition of Mango kernel flours (on dry weight basis).

Compounds %	*Sample (control)*	*Treatment*
		1% NaCl solution
Crude protein	5.93	5.22
Crude oil	12.39	12.97
Crude fiber	2.51	2.81
Total ash	2.37	2.45
Total carbohydrates	76.80	76.55

Table 2. Effect of soaking in 1% NaCl solution on minerals of mango kernel flours (on dry weight basis).

Mineral elements mg/ 100gm	*Sample (control)*	*Treatment*
		1% NaCl solution
Macro-elements		
Calcium	37.56	45.27
Phosphorus	59.91	69.72
Magnesium	169.37	188.49
Potassium	649.52	880.33
Sodium	289.98	327.37
Micro-elements		
Iron	0.71	0.84
Zinc	4.08	4.98
Copper	0.44	0.59

Table (2) Shows that mineral content of mango kernels proved to be a good source for some minerals such as Ca, P, Mg, K, Na, Fe, Zn and Cu. Also, it was observed that raising of macro mineral content after treatment with 1% NaCl solution especially, Potassium , Calcium , Phosphorus and Magnesium, as for the micro elements it could be noticed that soaking in 1% NaCl solution caused an increment in Copper , Zinc and Iron.

Table 3. Effect of soaking in 1% NaCl solution on physicochemical characteristics of mango kernels oil (on dry weight basis).

Properties	*Sample (control)*	*Treatment*
		1% NaCl solution
Refractive index 40·c	1.4692	1.4684
Melting point	34.22	34.56
Acid value	0.11	0.14
Peroxide value	0.74	0.82
Iodine value	43.60	43.64
Saponification value	189.65	189.59
Unsaponification matter %	1.52	1.21

From table (3) , it could be noticed that soaking in 1% NaCl solution caused a reduction of refractive index , saponification value and unsaponification matter i.e.

from 1.4642 to 1.4684 , 189.65 to 189.5 and 1.52 to 1.21 respectively .On the other hand, it could be observed that the aforementioned treatment caused slight increasing in melting point, acid value, peroxide value and Iodine value (Zygadlo et al 1994)

From table (4) , it could be noticed that soaking in alkaline solution 1% NaCl caused an increment of total unsaturated fatty acids and decrement of saturated fatty acids. These results agree with *Solis et. al., (2004).*

Table 4. Effect of soaking in 1% NaCl solution on fatty acid composition of mango kernels oil.

Fatty acids %	*Sample (control)*	*Treatment*
		1% NaCl solution
Lauric (12:0)	0.22	0.25
Myristic (14:0)	0.42	0.43
Palmitic (16:0)	11.74	11.39
Palmitoleic (16:1)	N.D	N.D
Stearic (18:0)	40.46	39.88
Oleic (18:1)	41.43	42.47
Linoleic (18:2)	5.57	5.43
Linolenic (18:3)	0.16	0.15
Total saturated	52.84	51.95
Total unsaturated	47.16	48.05

The changes in some antinutritional factors such as hydrocyanic acid, amygdaline, tannins, Phytic acid and trypsin inhibitor during treatment by soaking in 1% NaCl solution for 12 hrs., at 25 ± 2·c are shown in table (5). The results indicate that soaking treatment caused marked reduction in the antinutritional factors of mango kernels flour. The reduction rate in hydrocyanic acid and amygdaline was 100% for treatments. On the other hand, tannins and Phytic acid removal was higher in NaCl solution 1% than in control. Finally Treatments of mango kernels flour are free from Trypsin inhibitor. These results agree with *Radi (2005).*

Table 5. Effect of soaking in 1% NaCl solution on anti-nutritional factors of mango kernel flours (on dry weight basis).

Compounds	*Sample (control)*	*Treatment*
		1% NaCl solution
Hydrocyanic acid (gm/100gm sample)	0.05	N.D
Amygdaline (gm/100gm sample)	0.73	N.D
Tannins (gm/100gm sample)	56.46	35.34
Phytic acid (gm/100gm sample)	6.39	3.11
Trypsin inhibitor (TIU/mg)	N.D.	N.D.

N.D= not detected

Table 6. Effect of adding different levels of mango kernel flour on Chemical composition of prepared cake (on dry weight basis).

Type of cake		*Component %*				
		Protein	*Fat*	*Fiber*	*Ash*	carbohydrate
Control		11.71	16.91	1.39	1.63	68.36
	15%	16.27	17.93	1.61	1.91	62.28
(T)	25%	16.71	17.99	1.67	1.98	61.65
	35%	18.83	18.57	1.81	1.99	58.80

Table (6) shows the chemical composition of cake and the effect of adding mango kernels flour on the chemical composition of cake. From these data, it could be noticed that, protein, fat, fiber and ash contents tended to increase by increasing the level of added mango kernels flour. On the contrary, total carbohydrates tended to decrease with increasing the supplementation level.The rheological properties are considered to be of great importance since they greatly influence the final acceptability of the food products. The obtaind data are in agreement with those reported by *Radi (2005).and (Atwa et. al., 2008).*

Table 7. Effect of adding different levels of mango kernel flour on Rheological properties of wheat flour

Rheological data	*Control*	*15%*	*25%*	*35%*
Water absorption (%)	55.2	60.3	62.2	63.5
Arrival time (min)	1.5	2.5	3.0	3.5
Dough development (min)	2.5	3.0	3.5	3.5
Dough stability (min)	7.5	7.5	7.0	7.0
Degree of weakening (B.u)	45.0	55.0	60.0	65.0
Dough energy (cm^2)	120.2	118.3	115.2	110.1
Dough extensibility (mm)	210.0	210.0	205.0	200.0
Resistance to extension (B.u)	410.0	480.0	540.0	560.0
Proportional number (R/ E)	1095	2.29	2.63	2.80

Control: Wheat flour (72% extraction), Different levels of mango flours (15, 25&35%)

Table (7) indicates that dough stability, dough energy and dough extensibility decreased with increasing the percentage of mango kernels flour in the formula while water absorption, arrival time, dough development, degree of weakling, resistance to extension and proportional number were increased with increasing the percentage of mango kernels flour *(Atwa et. al., 2008).*

Table 8. Effect of adding different levels of mango kernel flour on Sensory evaluation of prepared cake

Type of cake		Color	Texture	Taste	Odor	Overall acceptability
Control		8.02^{ab}	7.53^{b}	7.99^{b}	8.02^{ab}	8.18^{ab}
	15%	8.54^{a}	8.32^{ab}	8.46^{ab}	8.20^{ab}	8.44^{ab}
T	25%	8.69^{a}	8.50^{a}	8.69^{a}	8.36^{ab}	8.74^{a}
	35%	7.33^{bc}	7.32^{bc}	7.17^{bc}	7.15^{bc}	7.30^{bc}
L.S.D		0.36	0.31	0.42	0.35	0.39

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 (8) indicate no significant difference between the control sample and the formulated meals containing mango kernels flour, especially for color and overall acceptability *(Radi 2005).*

Table 9. Effect of adding different levels of mango kernel flour on Microbial evaluation as C.F.U. /gm of prepared cake during storage at room temperature

Storage Period	Zero	Time	2	days	4	days	6	Days	8	days
Type of cake	T.C.	M.Y.	T.C.	M.Y.	T.C.	M.Y.	T.C.	M.Y.	T.C.	M.Y.
Control	50	25	70	40	90	60	120	90	160	100
15%	40	20	60	35	80	40	110	70	120	85
25%	35	15	40	30	70	30	100	60	100	75
35%	30	13	35	20	35	25	90	45	80	55

T.C = Total count

M.Y. = Mold and yeast

Table (9) shows the microbial evaluation of the final product during storage at the ambient temperature for 8 days. There was a trend decrease in the total viable count from the control up to the treatment 35% replacement at zero time storage, on the other hand, there was negligible numbers of molds and yeasts at zero time storage.

from the same table, it could be noticed that the neumerating of total count and mold and yast decresed by incresing the mango kernels flour addition than the control sample.

We suggest that this slow growth of the microbial count related to the contained polyphenols which have the fungistatic properties being play an important role in inhibition of molds and yeasts growth *(Nwokolo & Smartt 1996)*.

Overly we suggest that the prolongation of shelf – life at room temp. may be due to above mentioned factor in addition to the little amount of air contained in the headspace of the polyethylene sacks and the permeability of the polyethylene containers and the decrease in moisture content of the product

Table 10. Effect of adding different levels of mango kernel flour on Microbial evaluation as C.F.U. /gm of prepared cake during cold storage

Storage Period	Zero	time	7	days	14	days	21	Days	28	days
Type of cake	T.C.	M.Y.	T.C.	M.Y.	T.C.	M.Y.	T.C.	M.Y.	T.C.	M.Y.
Control	50	25	60	30	80	40	100	50	110	65
15%	40	20	50	25	70	30	80	40	100	50
25%	35	15	40	20	55	25	65	35	80	40
35%	30	13	35	15	45	20	60	25	75	30

T.C = Total count

M.Y. = Mold and yeast

By the same manner, Table (10) illustrated the microbial evaluation of the supplemented cake with mango flour during cold storage for 28 days.

The previous mentioned table demonstrated that the total viable count as c.f.u./ gm of the final product after cooling, the obtained data explained the effect of storage conditions on the microbial behavior along the storage periods . The microbial growth of all countered numbers, (Total Count, Molds and Yeasts) were slower than the samples stored at room temperature. Although, there were negligible numbers of molds and yeasts at the beginning of storage. The maximum growth of micro-organisms reached to 110 and 65 microbe /gm of the product after 28 days at cold storage with control while the lowest growth of microorganism with 35% mango kernel flour, this due to antioxidant agent. *(Nwokolo and Smartt 1996).*

The average change in body weight of rats is summarized in table (11). It could be observed that adding different percentages of mango kernels to the untreated flour was more effective for the growth of rats Compared to the treated (control). The increase of growth occurred with the increase in the percentage of added mango kernels flour.

Table 11. Food intake, body weigh and feed efficiency ratio for rats feeding on mango flours for 35 days

Diets*	Initial body weight (g/rat)	final body weight (g/rat)	Body weight gain		Daily gain in body weight (g/rat)	Daily food intake for rat (g/rat)	Feed efficiency ratio
			g/ rat	%			
Basal diet(+)	85	115	30	35.3	0.86	7.39	0.116
Control(-)	83	106	23	27.7	0.66	5.81	0.114
15%	86	117	31	36.1	0.89	7.83	0.114
(T) 25%	89	121	32	36.0	0.91	7.87	0.116
35%	88	120	32	36.4	0.91	7.87	0.116

*=Basal diet: casein, Control: proteins free Diet, T: mango flour by soaking in NaCl solution 1%

The data in table (11): show the evaluation of diet containing different percentage of control and treated mango kernels flour compared to those fed on added casein.

In general, mango kernels is a good source of high quality protein important in human and animal nutrition, and by blending with other plant proteins, will produce well balanced diets. Thus experiments must be carried out to study the acceptability of incorporation of mango kernels in some conventional of food items *(Difco 1986).*

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الإستفادة من دقيق بذور المانجو في تحسين منتجات المخابز

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تهدف هذة الدراسة إلى الاستفاده من مخلفات المانجو فى تحسين بعض منتجات المخابز حيث تم تقدير الخواص الطبيعية والكيمائية والريولوجية والبكتريلوجية والبيولوجية لبذور المانجو والتى عوملت للتخلص من المواد السامه (الامجدالين وحمض الهيدروسيانيك ومثبطات انزيم التربسين) بنقعها فى محلول كلوريد الصوديوم 1% وأدت هذة المعاملة الى نقص طفيف فى محتواها من البروتين والكربوهيدرات كذلك تأثرت الخواص الطبيعية لزيت بذور المانجو مثل حدوث زيادة فى رقم الحموضة ورقم البيروكسيد ونقص فى المواد الغير قابلة للتصبن . لم يحدث تأثر لبذور المانجو فى محتوى الدهون والاحماض الدهنية بهذة المعاملة , كما أن المنتج المدعم بأضافة نسب مختلفة من دقيق بذور المانجو المعامل أدى الى حدوث زيادة فى محتواها من البروتين والدهون والالياف والرماد عملا على تحسين قيمتها الغذائية بينما إنخفض محتواها من المواد الكربوهيدراتية كما أن هذه الاضافة أدت الى تحسين فى الخواص الريولوجية للمنتج وقد أشارت نتائج التحليل الاحصائى إلى عدم وجود اختلاف معنوى فى الخواص الحسية للمنتج المدعم بأضافة دقيق بذور المانجو المعامل. من ناحية أخرى زادت فترة الحفظ بما يعادل ثمانية أيام على درجة حراره الغرفة و 28 يوم على درجة حرارة الثلاجة. أظهرت النتائج البيولوجية زيادة ملحوظة فى اوزان فئران التجارب بعد نهاية فترة التجربة وبخاصة بزيادة نسبة الإضافة.