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UTILIZATION OF MANGO SEED KERNELS AFTER REMOVING ANTINUTRITIONAL MATTERS IN BISCUIT PRODUCTION

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ABSTRACT

In Egypt, more than four million tons of mango fruits were produced annually. After consumption or industrial processing of the fruits, considerable amounts of mango seeds are discarded as waste. The seed kernels can be used in some food products to contribute in dissolving of environmental pollution problem due to the waste of food processing plants and to minimize the production costs. This study was carried out to remove the antinutritional matters from mango seed kernels (tannins, phytic acid and total phenols) by different treatments. Treated mango seed kernels were used to prepare semi hard sweet biscuits (tea biscuits) as commercial products. Chemical composition and mineral contents and amino acids composition for mango seed kernels meal were determined. The mango seed kernels meal was replaced at different levels (5, 10, 15 and 20%) from wheat flour (72% extraction) for preparing biscuits. The quality attributes of biscuits made from wheat flour (72% extraction) as control or replaced by different levels of mango seed kernels meal were studied. Sensory evaluation for biscuits was studied and the data were statistically analyzed. The results indicated that, mango seed kernels meal contains a good percentage of main components and acceptable percentage from essential amino acids. The nutritional values for biscuits contained seed kernels meal were slightly higher than control biscuits. Data for sensory evaluation indicate the addition of mango seed kernels meal till 10% was acceptable. Finally, the mango kernel seeds meal could be utilized in making some cereal products.

Key words: Mango seed kernels– Wastes – Biscuit – Antinutritional matters.

INTRODUCTION

Mango (*Mangifera indica* L. Anacardiacea) is one of the most important tropical fruits in the world and currently ranked 5th in total world production among the major fruit crops (FAO, 2004). According to mango varieties, the seed represents from 10 to 25% of the whole fruit weight (Hemavathy *et al.*, 1988). The seed presents from 8.1 to 23.2% of the whole fruit weight according to mango varieties. The kernel inside seed represents 24.1 to 50.0% of the seed and 12.5% of whole fruit (Arogba, 1997).

In Egypt, more than four million tons of mango fruits were produced in 2004/2005 (Anon, 2005). After consumption or industrial processing of the fruits, considerable amounts of mango seeds are discarded as waste (Puravankara *et al.*, 2000).

Concerning the chemical composition of mango seed kernels, several were carried out in order to utilize mango kernels in food industry. The kernel contains considerable amounts of starch, protein, fat and ash. These kernels depending on the variety contain on average 5.7-6.8% protein, 7.5-9.3% fat, 1.3-2.0% crude fiber, 2.2-3.1% ash and 75.2-79.9% carbohydrates (Bhatnager and Subramanyam, 1971 and Augustin and Ling, 1987). Depending on their variety, mango seed kernels contain 6.0% protein, 11.0% fat, 77.0% carbohydrate, 2.0% crude fiber and 2.0% ash, on a dry weight average (Zein *et al.*, 2005).

Abdalla *et al.* (2007) reported that the moisture content of fresh mango seed samples was on average 50.7% while the moisture content of dried mango seed kernels powder samples was on average 8.5%. Crude protein, total lipid, crude fiber and ash contents of mango seed kernels were found to be 6.7%, 12.3%, 2.7%, and 2.5% on a dry weight basis, respectively. Mango seed kernels contained 112 mg total polyphenols per 100 g dry seed kernel powder.

Hammam (2007) found that mango seed kernel flour contained 5.7% moisture, 11.17% fat, 7.0% protein, 1.29% ash, 4.75% crude fiber and 70.09% carbohydrates (on dry weight basis). Besides these constituents the mango kernel powder also contained 0.21% total phenolic compounds

Although mango seed kernels have a low content of protein, the quality of protein is good (Seleim *et al.*, 1999). The amino acid profile of different varieties of mango seed kernel protein contains the most of the essential amino acids, with highest values of leucine, valine and lysine (Diaz and Coto, 1983 and Shahinaz, 2001). Also, El-Soukkary *et al.* (2000) reported that mango seed kernels had high lysine content (3.479/100 g) and amino acid score (63.1%) compared with wheat flour (2.05 g/100 g) and (37.27%), respectively. Rukmini and Vijayaraghavan (1984) indicated that mango seed kernel fat is promising and a safe source of edible oil and was found to be nutritious and non-toxic so that it could be substituted for any solid fat without adverse effects.

Dhingra and Kapoor (1985) reported that the mango seed kernel had 5% protein, 6-7% fat, and 0.19-0.44% tannins. Arogba (2000) found that moist heat at 90°C inactivated PPO by 50% of its maximum activity within 3 min. Furthermore, up to 90% inactivation could be achieved after 5 min of water blanching, thereby reducing significantly the rate of undesired browning leading to tannin formation. Water-blanching would advantageously leach soluble tannic substances into the soak-water.

Mango seed kernels were shown to be a good source of polyphenols, phytosterols as campesterol, b-sitosterol and tocopherols (Soong *et al.*, 2004).

Soong *et al.* (2004) suggested that mango seed kernel could be used as a potential source for functional food ingredients due to its high quality of fat and protein as well as high levels of natural antioxidants. Moreover, Zein *et al.* (2005) published that soaking and boiling treatments had a great impact in reducing of the anti-nutritional factors. So the processed flour could be a principal ingredient for making products such as cakes and cookies for infants and adults and also other products such as bread and pastry.

Various studies reported that mango seed kernels contain different phenolic compounds and stable fat rich in saturated fatty acids so that it can be a good source of natural antioxidants (Parmar and Sharma, 1984; Puravankara *et al.*, 2000; Nunez-Şelles, 2005 and El-Bastawesy *et al.*, 2007).

The chemical composition of American wheat flour (72% extraction) was: 9.86-11.57% protein, 0.52-0.75% ash, 1.13-1.28% fat, 0.40-0.46% fiber and 74.03-86.00% total carbohydrates (on 14% moisture basis) (Hassanen, 1998; Abd-El Rahim *et al.*, 2001 and Doweidar, 2001)

The performance of mango kernel flour in biscuit-baking was conducted by Arogba (1999). The biscuit was contained equal proportion (50:50) of the processed mango kernel flour and wheat flour. The percentage proximate composition of both biscuits was not similar. Thus, moisture, protein, fat, fiber, ash and total carbohydrates were 5.0-7.7, 4.0-6.8, 18.2-29.5, 0.1-1.0; trace-1.1 and 61.4-65.2%, respectively

Therefore, this study was a trial to utilize some food industries wastes namely mango seed kernels meal as untraditional supplement in biscuit making.

MATERIALS AND METHODS

Materials:

Wheat flour (72% extraction rate), egg, sugar, corn oil, skimmed milk powder, ammonium bicarbonate and vanillia obtained from local market from Tukh, Kalyobia, Egypt.

During the summer season of 2008, about 200 kg seeds of mango fruits (Zebda and Balady) as waste were obtained from Kaha Company for Food Preservation, Kaha, Kalubyia Governorate, Egypt.

Methods:

Preparation of mango seed kernels:

The seeds were washed and air dried and the kernels were removed manually from seeds. The kernels were divided into three parts, first part without treatment (control), second part was soaked in tap water for 48 hr at room temperature (26±2°C) and third part was soaked in sulphited tap water (0.73 g/liter sodium metabisulfite) for 48 hr with occasional decantation and replacement with an equivalent amount of water until the water remained colorless. During soaking period, samples were withdrawn at 24 and 48 hr according to the method described by Arogba (1997).

Part of each of raw kernels (control), either kernels soaked in tap water and in sulphited tap water after 48 hr were autoclaved at 100°C for 30 minutes, cut to small parts and dried at 60°C in electric oven for 12 hr. The dried kernels for three parts were ground in a hammer mill (Apex Wiley provided with a 100 mesh sieve) for a powder form. The produced meal were kept in polyethylene bags until used.

Preparation of biscuit:

The prepared milled seeds were used in the preparation of biscuit. Biscuits were prepared according to the standard procedure for semi hard sweet biscuits (tea biscuits) (Ibrahim, 2003). Four biscuit blends were prepared according to the formula shown in Table (A).

Table (A): Formula of different biscuit blends (gram).

Components	Blends				
	Control	1	2	3	4
Wheat flour (72% ext.)	100	95	90	85	80
Mango seed kernels meal	-	5	10	15	20
Sugar	30	30	30	30	30
Corn oil	15	15	15	15	15
Skimmed milk powder	0.5	0.5	0.5	0.5	0.5
Ammonium bicarbonate	0.66	0.66	0.66	0.66	0.66
Sodium bicarbonate	0.33	0.33	0.33	0.33	0.33
Fresh whole egg	24.0	24.0	24.0	24.0	24.0
Vanillia	0.30	0.30	0.30	0.30	0.30

Chemical analysis:

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

Minerals (Sodium, potassium, calcium, Magnesium, manganese, iron, zinc, copper and nickel) contents were determined as described by A.O.A.C. (2000) using a Pye Unicom SP 19000 atomic absorption spectroscopy in Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Phosphorus was determined colorimetrically according to the methods described in A.O.A.C. (2000).

Energy values:

Total calorie estimates (kcal) for biscuit were calculated on the basis of a 100 g sample using Atwater values for fat (9 kcal/g), protein (4.02 kcal/g) and carbohydrate (3.87 kcal/g) (Mansour and Khalil, 1997).

Energy values = (carbohydrate X 3.87) + (protein X 4.02) + (fat X 9)

Determination of tannins:

Tannins in the methanol extracts was measured according to the vanillin method of Price *et al.* (1978). The developed color was read at 500 nm after 20 min at room temperature. A standard curve was prepared using catechin. Tannin content was expressed in mg catechin equivalents.

Determination of phytic acid:

Phytic acid was estimated colorimetrically using Wade reagent (Latta and Eskin, 1980).

Determination of total phenols:

The polyphenolic compounds were determined as described by Swain and Hills (1959).

Determination of amino acids composition:

Amino acids composition was determined according to the method described by Ozols (1990) using Beckman amino acid analyzer (Model 119 CL) at the Alexandria University. One hundred milligrams of ground samples were hydrolyzed, filtered through a Whatman No. 42 and diluted to 25 ml. Two milliliter of filtrate was placed in a vacuum desiccators until dryness. The dry residue was dissolved in a 5 ml sodium citrate buffer (pH 2.2) and used for amino acid analysis. Tryptophan was colorimetrically determined in the alkaline hydrolysate of samples according to the method of Blouth *et al.* (1962).

Organoleptic evaluation:

The organoleptic characteristics of biscuits were determined, using a taste panel, consisting of 10 judges. The panelists were asked to evaluate the products for appearance, colour, texture, flavour and overall acceptability. The ratings were on a 9-point hedonic scale, ranging from 9 (like extremely) to 1 (dislike extremely), for each organoleptic characteristic according to the method of Austin and Ram (1971) as mentioned by Hooda and Jood (2005) and Sudha *et al.* (2007).. Results were subjected to analysis of variance.

The 9-point hedonic scale (Stone and Sidel 2004) is as follows:

(9) Like extremely. (8) Like very much.
(7) Like moderately. (6) Like slightly.
(5) Neither like nor dislike.
(4) Dislike slightly.
(3) Dislike moderately.
(2) Dislike very much.
(1) Dislike extremely.

Statistical analysis:

ANOVA was applied on data of effect of soaking treatments and heating in autoclave on antinutritional matters in mango seed kernels and organoleptic evaluation of different samples of biscuit which were treated as data for complete randomization design. Least significant difference (L.S.D.) was calculated at 0.05 level of significance according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of soaking and heating in autoclave on antinutritional matters in mango seed kernels:

Some antinutritional substances in mango seed kernels meal must be determined to evaluate these wastes as safety food ingredients for human utilization (El-Bastawesy *et al.*, 2007). In this study treatments such as raw seed kernels (control), soaking in tap water for 24 and 48 hr, soaking in sulphited tap water for 24 and 48 hr, raw after treatment in autoclave, after soaking in tap water for 48 hr and after soaking in sulphited tap water for 48 hr were applied and the results are presented in Table (1). It was observed that soaking either in tap water and in sulphited tap water had reduced tannins (46.05 and 45.70%), phytic acid (38.84 and 39.29%) and total phenols (30.56 and 33.33%) after 48 hr, respectively. Also, heating in autoclave had reduced tannins (91.06, 93.64 and 93.47%), phytic acid (87.57, 80.36 and 81.25%) and total phenols (91.66, 93.06 and 93.06%), for raw, soaked in tap water for 48 hr and soaked in sulphite tap water for 48 hr, respectively. These results are in agreement with Arogba (2000).

Data in Table (1) indicate that highest removing percentage of antinutritional matters was obtained by autoclaving. There are no significant (p>0.05) differences between autoclaved samples without or with soaking in tap water or sulphited tap water for 48 hr. So that it could recommend to use heating in autoclave at 100°C for 30 min to remove more than 78% of antinutritional matters in preparing mango seed kernels to be used in biscuit production.

Table (1): Effect of soaking treatments and heating in autoclave on antinutritional matters in mango seed kernels (mean±SE).

Treatments	Components					
	Tannins	% Removing	Phytic acid	% Removing	Total phenols	% Removing
Raw seed kernels (control)	5.82±0.03 a	-	2.24±0.02 a	-	0.72±0.02 a	-
After soaking in water for 24 hr	3.78±0.02 b	35.05	1.75±0.02 b	21.88	0.64±0.01 b	11.11
After soaking in water for 48 hr	3.14±0.02 c	46.05	1.37±0.01 c	38.84	0.50±0.01 c	30.56
After soaking in sulphite tap water for 24 hr	3.76±0.04 b	35.40	1.76±0.02 b	21.43	0.60±0.01 b	16.67
After soaking in tap water sulphite for 48 hr	3.16±0.01 c	45.70	1.36±0.03 c	39.29	0.48±0.02 c	33.33
Raw after treatment in autoclave	0.52±0.02 d	91.06	0.48±0.02 d	78.57	0.06±0.01 d	91.66
After soaking in water for 48 hr and autoclaved	0.37±0.02 d	93.64	0.44±0.01 d	80.36	0.05±0.01 d	93.06
After soaking in sulphite tap water for 48 hr and autoclaved	0.38±0.01 d	93.47	0.42±0.02 d	81.25	0.05±0.02 d	93.06
L.S.D. at (P<0.05)	**0.17**	-	**0.08**	-	**0.04**	-

a, b, c and d: There is no significant difference (P>0.05) between any two means, within the same column.

Chemical composition of raw materials:

Data in Table (2) show the major components of mango seed kernels meal were carbohydrates (76.30%) followed by ether extract (10.31%), crude protein (7.23%), crude fiber (3.95%) and ash (2.21%). Data in the same table indicate that mango seed kernels meal had higher ether extract, ash and crude fiber contents compared with those of wheat flour.

Generally the obtained values were in line with those reported by Van Pee *et al.* (1981) and El-Soukkary *et al.* (2000). While, Arogba (1997) had higher value of fat (14.0%) and lower value of protein (5.3%), Crude fiber content of mango seed kernels meal (3.95%) (Table 2) was higher than that reported by the previous investigators, but it is lower than the value of 4.75% reported by Hammam (2007).

Table (2): Gross chemical composition of wheat flour and mango seed kernels meal (Gross mean±SE).

Components	Wheat flour	Mango seed kernels meal after treatment by autoclave
Moisture	11.94±0.36	7.86±0.21
Crude protein*	10.26±0.18	7.23±0.19
Ether extract*	1.08±0.16	10.31±0.32
Ash*	0.56±0.08	2.21±0.18
Crude fiber*	0.42±0.10	3.95±0.16
Carbohydrate*[@]	87.68	76.30

*: On dry weight basis. [@]: Carbohydrate by difference

Minerals content:

Data in Table (3) represent the minerals content of wheat flour and mango seed kernels meal after treating by autoclaving. It is clear that mango seed kernels meal was superior in potassium, calcium, magnesium, manganese, iron, zinc, copper and nickel, while, wheat flour (72% extraction) was superior in sodium and phosphorus. These results for wheat flour (72% extraction) are in agreement with those reported by Cara *et al.* (1992). Generally, from these results, it could be observed that calcium, iron, zinc contents of mango seed kernel were found to be in a high quantity. These results are in accordance with these of El-Bastawesy *et al.* (2007). Therefore it could be mentioned that fortification of wheat flour with mango seed kernels meal can produce biscuits with high levels of minerals.

Table (3): Minerals contents of wheat flour and mango seed kernels meal (mg/100 g).

Minerals	Wheat flour	Mango seed kernels meal after treated by autoclave
Na	24.62	10.08
K	142.38	367.82
Ca	13.10	57.24
P	136.24	142.16
Mg	114.22	100.22
Mn	0.68	0.84
Fe	0.70	0.60
Zn	0.51	0.49
Cu	0.30	0.28
Ni	0.07	0.04

Amino acids composition:

Data in Table (4) indicate the amino acids composition of mango seed kernels meal. Data showed that mango seed kernels meal protein was considered a poor source of methionine, cystine and tyrosine. On the other hand, leucine and isoleucine are the predominant essential amino acids. Lysine (5.68%) was higher than that of wheat flour (2.63%). Also, essential amino acids represented 39.34% of total amino acids. The most of essential amino acids were higher levels than in the FAO (1993) reference. Among most non-essential amino acids content were higher in mango seed kernels meal compared to wheat flour. However, when amino acids were compared with those of whole egg protein (FAO, 1973), methionine, valine, isoleucine, lysine, threonine and phenylalanine were present in lesser amounts but tryptophan, histidine and cystine in greater amounts.

These results were parallel with those reported by Arogba (1997). They found that amino acids presented in the greatest amount in mango seed kernels four protein were glutamic (24.27-27.5%) and aspartic (13-15%).

Table (4): Amino acid composition of mango seed kernels meal compared with wheat flour, whole egg protein and FAO reference protein (g amino acid per 100 g protein)

Amino acids	Mango seed kernel	Wheat flour 72%*	Whole egg protein**	FAO reference protein***
Essential amino acids:				
Leucine	6.93	7.18	8.8	4.8
Isoleucine	5.23	3.68	6.2	4.2
Methionine	1.18	1.75	3.3	2.2
Phenylalanine	4.15	4.90	5.7	2.8
Lysine	5.68	2.63	6.9	4.2
Threonine	3.24	2.98	-	4.0
Tyrosine	2.95	3.33	1.5	4.1
Valine	5.96	4.90	6.8	4.2
Tryptophan	1.70	1.23	1.5	
Cystine	2.32	2.80	2.4	
Non-essential amino acids:				
Aspartic	9.21	5.43	9.6	
Glutamic	21.62	28.09	12.3	
Serine	4.83	5.78	7.6	
Proline	4.83	9.55	-	
Glycine	4.70	4.38	3.3	
Alanine	4.38	4.03	5.9	
Histidine	3.25	2.28	2.4	
Arginine	7.84	5.08	6.1	
Total essential amino acids %	39.34	35.38	-	
Total non-essential amino acids %	60.66	64.62	-	

* Source: Paul and Southgate (1979). ** FAO (1973). *** FAO (1993)

Chemical composition of biscuits produced from soft wheat flour 72% extraction rate substituted with mango seed kernels meal.

Data in Table (5) indicate the chemical composition of biscuits as influenced by different levels of mango seed kernels meal.

It was found that, ether extract, fiber and ash increased with increasing the different levels of mango seed kernels meal. While crude protein and total carbohydrates decreased with increasing the level of mango seed kernels meal levels.

Table (5): Chemical composition of biscuit produced from soft wheat flour 72% extraction rate substituted with mango seed kernels meal (mean±).

Components	Control	Treatments			
		1	2	3	4
Moisture %	5.50±0.23	5.62±0.21	5.78±0.26	5.45±0.18	5.80±0.20
Crude protein* %	8.41±0.18	8.35±0.12	8.28±0.15	8.18±0.20	8.06±0.16
Ether extract* %	12.06±0.14	12.38±0.10	12.66±0.16	12.90±0.31	13.27±0.15
Crude fiber* %	0.50±0.06	0.58±0.05	0.63±0.06	0.70±0.06	0.82±0.0.08
Ash* %	1.08±0.06	1.12±0.08	1.20±0.05	1.31±0.04	1.38±0.12
Total carbohydrates*@%	77.95	77.57	77.23	76.89	76.47
Energy value (kcal/g)	444.01	445.18	446.11	446.55	447.77

* : On dry weight basis. @ : by difference.

Control : 100% Wheat flour 72% extraction rate.

1: 95% wheat flour + 5% mango seed kernels meal. 2: 90% wheat flour + 10% mango seed kernels meal.

3: 85% wheat flour + 15% mango seed kernels meal. 4: 80% wheat flour + 20% mango seed kernels meal.

Organoleptic evaluation of biscuits produced from soft wheat flour 72% extraction rate substituted with mango seed kernels meal.

The sensory characteristics, i.e. color, texture, taste, flavor, appearance and overall acceptability of biscuits prepared from wheat flour containing mango kernels meal with different levels were evaluated by ten panelists and the data obtained were statistically analyzed as shown in Table (6).

The obtained data could be noticed that supplemented with 5% mango seed kernels meal to soft wheat flour 72% extraction rate produced biscuits with average grade of like very much for all the evaluated attributes without significant difference (p>0.05) compared to control. In spite of, addition of mango seed kernels meal up to 10% showed significant decrease (p<0.05) in some sensory attributes of biscuits, average grade of all quality attributes were greater than 7. This indicates that the produced biscuit with 10% mango seed kernels meal has like moderately quality grade. Also, biscuits supplemented with mango seed kernels meal until 15 and 20% have significant differences (p<0.05), compared to control, but they obtained like slightly quality grade.

Table (6): Sensory evaluation of biscuits produced from soft wheat flour supplemented with different levels of mango seed kernels meal (mean±SE).

Treatment		Color	Texture	Taste	Flavor	Appearance	Overall acceptability
Control		8.91±0.11 a	8.87±0.12 a	8.78±0.12 a	8.87±0.14 a	8.82±0.11 a	8.87±0.09 a
Treatments	1	8.33±0.25 a	8.73±0.16 a	8.64±0.24 a	8.73±0.14 a	8.55±0.23 a	8.39±0.13 ab
	2	7.34±0.15 b	8.60±0.24 a	8.46±0.19 a	8.55±0.32 ab	7.52±0.16 b	7.87±0.22 b
	3	6.57±0.19 c	7.97±0.17 b	7.92±0.27 b	8.42±0.24 ab	6.71±0.15 c	7.22±0.18 c
	4	5.63±0.24 d	7.11±0.14 c	7.38±0.15 c	8.08±0.16 b	5.72±0.09 d	6.80±0.22 c
L.S.D. at 0.05		0.73	0.43	0.33	0.48	0.38	0.53

a, b, c and d: There is no significant difference (P<0.05) between any two means, within the same column. have the same letter

Control : 100% Wheat flour 72% extraction rate.

1: 95% wheat flour + 5% mango seed kernels meal.

2: 90% wheat flour + 10% mango seed kernels meal.

3: 85% wheat flour + 15% mango seed kernels meal.

4: 80% wheat flour + 20% mango seed kernels meal.

CONCLUSION

The obtained results were a trial to utilize mango seed kernels meal in biscuit production which could be used at level 10%. This help to minimize the environmental pollution due to mango processing waste. Also it partially dissolves the problem of deficiency in wheat production.

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استخدام جنين بذورالمانجو بعد إزالة مثبطات التغذية فى إنتاج البسكويت

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نظرا للزيادة المطردة والكميات الكبيرة التى تنتج من المانجو سنويا وبالتالى فهناك كميات كبيرة من المخلفات والتى تسبب مشكلة للمصانع فى كيفية التخلص منها للحد من التلوث البيئى. فقد هدفت هذه الدراسة إلى الاستفادة من تلك المخلفات بحيث توفر جزء من الدقيق المستخدم فى صناعة البسكويت وأيضا الاستفادة من قيمتها الغذائية ومحتواها العالى من الأحماض الأمينية وكذلك الاستفادة من مضادات الأكسدة التى تحتويها وذلك بعد التخلص من مضادات التغذية. وكذلك تحويلها من مشكلة للمصانع إلى مواد ذات عائد اقتصادى.

ففى هذه الدراسة تم استخدام مطحون جنين بذور المانجو بعد التخلص من مضادات التغذية (التنينات – حمض الفيتيك – الفينولات الكلية) فى استبدال جزء من الدقيق بنسب صفر، ٥، ١٠، ١٥ و ٢٠% فى تصنيع البسكويت.

وقد تم إجراء التحليل الكيماوى لمطحون جنين بذور المانجو لمعرفة محتواه من المركبات الرئيسية واتضح محتواه العالى من المستخلص الأثيرى (١٠,٣١%) والكربوهيدرات (٧٦,٣٠%) ونسبة جيدة من البروتين (٧,٢٣%) وكذلك ارتفاع محتوى العناصر المعدنية والأحماض الأمينية التى تتفوق فى معظم الأحماض عن محتواها فى دقيق القمح.

وتم تصنيع البسكويت باستخدام نسب الاستبدال السابقة. وقد تم التحليل الكيماوى والتقييم الحسى للبسكويت المصنع. وأظهرت نتائج التحليل الإحصائى أنه لا يوجد فرق معنوى بين الكنترول والبسكويت المصنع بنسبة إستبدال ٥% من الدقيق بمطحون جنين بذور المانجو ولكن هناك بعض الفروق المعنوية بين البسكويت المصنع بنسبة إستبدال ١٠% مقارنة بالبسكويت الكنترول. ورغم ذلك كانت القابلية العامة للبسكويت المصنع بنسبة استبدال ١٠% مقبولة بدرجة كبيرة مقارنة بالكنترول.

ولذلك نوصى بالاستفادة من مطحون جنين بذور المانجو وإضافته إلى الدقيق المستخدم فى تصنيع البسكويت بنسبة تصل إلى حوالى ١٠%.