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Evaluation of New Untraditional Chocolate Filled with some Fruits and Oat

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Abstract: Many children and adults suffered from a chronic malnutrition diseases. Besides increasing the consumption of certain types of foods with high content of fats and sugars, which may lead to many diseases especially obesity. Thus the aim of this study was to produce new untraditional products from chocolate filled with fruit pulp and roasted oat which have been evaluated as well as source natural colors and flavor instead of the artificial ones harmful to human health. The obtained results indicated that, the increase level of oat caused increment in protein, fat, total phenolic contents and β-Glucan with decrement incrude fibres, ash, total carbohydrates, total carotenoids and anthocyanin contents, and an increase in antioxidant activity. The produced filled chocolate could provide average 23.38 and 23.85% of the recommended daily intake (RDA) for adults from protein and considered good sources of phosphorus and iron and responsible for providing a quantity of the human body requirements. The color index, peroxide value and microbiological characteristics until six months at 5±2ºC and the sensory evaluation for the filled chocolate were also investigated. The color index and peroxide value significantly increased during storage periods while, the greater addition of roasted oat resulted in a higher stability of the treatments at the end of storage periods. Meanwhile, the microbiological characteristics of the filled chocolate products were within palatable and below the permissible limits. The filled chocolate with fruit pulp and roasted oat treatments was approved by the sensory panel. From the index of acceptance (IA), formulations TC2 and TC7 with ratios of 53.2: 26.6% (fruit pulp: oat) had the best acceptance 91.77 and 90.33%, respectively compared to the other formulations.

Keywords**:** Filled chocolate, mango, strawberry, oat and recommended daily intake

INTRODUCTION

Practice of the world shows that, a consumer chooses products, which can be used in nutrition without spending much time for their preparation. Use of fruit desserts in nutrition is one of the ways to consume vitamins and minerals. Food is an essential part of everyone's lives. It provides us the energy and nutrients to grow and develop, be healthy and active, to move, work, play, think and learn. Foods with wide palatability and consumption have been enriched with ingredients that potentially improve the consumers' health. For instance, reducing the fat content in the diet decrease the energy intake and therefore, contribute to the prevention of obesity. There is an opportunity using indulgent foods, such as chocolate to achieve this aim (Galoburda *et al*., 2014; Rezende *et al*., 2015). It has been reported that most commercially available chocolate is rich in fat, simple sugar and calories (Greenberg *et al*., 2015). This may contribute to excess energy intake and subsequent gain weight in the long-term, which in turn may increase the risk of cardiovascular disease and type 2 diabetes (Salmeron *et al*., 2001). The rise in cardiovascular disease and obesity and in other diet-related illnesses has led to consumers taking a greater interest in the ingredients of food products and valuing those with functional foods. Consumers prefer to consume functional foods as a member of the specific food category to which they belong (Ares *et al*., 2010). The problem of obesity is not limited to the rich people, but also prevalent in poor consumers due to the consumption of high-calorie foods, and low in nutritional values. The Food and Agriculture Organization (FAO) reported that, Egypt suffered from a chronic malnutrition among children under five years of age, and obesity in adults. About 25% of Egyptians are suffering from deficiencies in iron, zinc and Vitamin A (WFP, 2013). Furthermore, increasing the consumption of refined carbohydrates, saturated fats and sugars has simultaneously increased risks for malnutrition and obesity (UNICEF, 2013). Development of new food products with improved quality and health benefits have been gaining increasing attention in recent years. In this regard, the highest amount of bioactive compounds can be found in the fruit. Mango (*Mangifera indica L.*) is one of the most important tropical crops. Egypt is one of the major producer countries in Africa. In Egypt mango becomes one of the main fruit crops which ranks the second after citrus. Mango plants produce fleshy stone fruits rich in phytochemicals with an undisputed nutritional value for its high content of polyphenolics and carotenoids (provitamin A), antioxidant, anti-inflammatory, and anticancer properties of mango, a fruit that should be included in everyone's diet for its multifaceted biochemical actions and health-enhancing properties (Lauricella *et al*., 2017). Strawberry fruits (*Fragaria x ananassa*) in family Rosaceae is an important popular and widely consumed fruit. Strawberries are one of the most widely consumed fruits both in fresh and processed form such as juice, beverage, jam, puree or powder. Strawberry fruits are rich in natural antioxidants, including anthocyaniens, flavonoids and phenolic compounds (Erkan *et al*., 2008; Galoburda *et al*., 2014), which might provide human health properties. It has gained popularity very quickly among the consumers for its characteristic aroma, bright red color, juicy texture, sweetness and excellent dietary sources of vitamin C, manganese, iron, potassium, fiber and other minerals (Perez *et al*., 1997). Oat consumption may be a beneficial dietary intervention for reducing fat accumulation, augmenting health span, and improving hyperglycemia-impaired lipid metabolism. In addition

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to their fermentable dietary fiber and the soluble β-glucan fiber, oat have unique avenanthramides that have anti-inflammatory and antioxidant properties that reduce coronary heart disease in human clinical trials. Oat consumption will increase insulin sensitivity, reduce body fat, and improve health span. In the same way, Oats (*Avena sativa L.*) ranks around sixth in the world cereals production statistics following wheat, maize, rice, barley and sorghum. They are good source of proteins, fibre and minerals. The amount of oats used for human consumption has increased progressively, the fact health effects of oats benefits mainly on the total dietary fibre and β - glucan content (Ahmad *et al*., 2014; Chenfei *et al*., 2015). Oat is reported as, they are used for their antioxidants, anti-inflammatory, moisturizing and even ultraviolet protecting properties. As a grain without gluten, oat flour and bran are used as alternative foods for persons suffering celiac disease. Oats have been recognized functional foods, because provide beneficial effect on the health of the consumer and decrease the risk of various diseases. The valuable physiological and nutritional attributes of oat by β - glucans and other dietary fibre components, high tocopherol and natural antioxidant level have generated an increased demand for oats in human nutrition, mentioned by Sterna *et al*. (2016). In addition, as a potential source of low-cost proteins, oat has the highest level of protein within the scope of 15% to 20% with well-balanced amino acid composition among all the cereals. Oat protein has higher nutritive and biological value resulting from lack of anti-nutritional factors and relatively abundant restrictive amino acids such as lysine.

The present study is an attempt to produce filled chocolate with fruits pulp as a source of natural color and flavor instead of artificial ones which is harmful to health as well as added roasted oat to verify the improvement of protein and bioactive compounds which is characterized high nutritive value, popular, palatable, delicious and economic.

MATERIALS AND METHODS

Materials

Mango (*Mangifera indica L.*) and strawberry (*Fragaria x ananassa*) fruits were purchased from the Horticultural Research Institute, Agriculture Research Center, Giza, Egypt. Glucose syrup, citric acid, and guar gum, white chocolate, skimmed milk powder, oat (*Avena sativa L.*), were obtained from the local market of confectionery product distributors.

Methods

Technological methods

Preparation of concentrated mango and strawberry pulp

The mango fruits were washed, then manually peeled and de-stoned by stainless steel knife. The flesh was blended in blender (model-Brown, Germany) and then screened. The pulp was concentrated by rotary evaporator (Stuart, R.E.300-UK) under vacuum 28 mmHg at 45-50ºC. The concentration process was continued until the total soluble solids (T.S.S) of the pulp concentrate reached to 34%. The strawberries uncapped were washed followed by sorting, the pulp was extracted using juice extracting machine blender (model-Brown, Germany), and then screened. The pulp was concentrated by rotary evaporator (Stuart, R.E.300-UK) under vacuum 28 mm Hg at 45-50ºC. The concentration process was continued until the total soluble solids (T.S.S) of the pulp concentrate reached to 25.5%.The concentrated pulp was stored in sterile containers at -18ºC for further processing. Both mango and strawberry screened pulp were mixed with 0.1% sodium benzoate and 0.1% ascorbic acid before concentration process.

Roasting of oats

Roasting of oat was done by following the method of Fares and Menga (2012). Oat was conditioned to moisture content of 10% to maintain uniformity during roasting process and then roasted at 115±2ºC for 3 h in an air oven.

Preparation of fruit mixtures

Ten fruit mixtures formulas were prepared by mixing the ingredients, heating the glucose-corn syrup to boiling temperature and thoroughly blending with the premixed dry ingredients (Fig.1). The quantities of the ingredients that were presented in all the formulations are shown in Table (1).

Table (1): Different blends from fruits and oat prepared

Treatments	Variable ingredients %			Fixed ingredients %	
	Roasted oat %	Mango pulp%	Strawberry pulp %	Glucose syrup %	Skimmed milk %
T1	13.3	66.5	-	6.8	13.4
T2	26.6	53.2	-	6.8	13.4
T3	39.9	39.9	-	6.8	13.4
T4	53.2	26.6	-	6.8	13.4
T5	66.5	13.3	-	6.8	13.4
T6	13.3	-	66.5	6.8	13.4
T7	26.6	-	53.2	6.8	13.4
T8	39.9	-	39.9	6.8	13.4
T9	53.2	-	26.6	6.8	13.4
T10	66.5	-	13.3	6.8	13.4

Guar gum 0.2%, citric acid 0.1%, potassium sorbate 0.5% and ascorbic acid 1%

Glucose Syrup
↓
Boiling and stirring
↓
Adding roasted oat
↓
Adding pasteurized concentrated fruit pulp (Mango or strawberry 75±2ºC /20min)
↓
Adding skimmed milk powder
↓
Heating and stirring (Adding preservative and Additives)
↓
Lamination (Bonding thin mixture together)
↓
Moulding
↓
Cooling
↓
Forming
↓
Coating with melting chocolate
↓
Cooling
↓
Packing (in laminated aluminium foil)
↓
Stored at 5±2ºC

Figure (1): Flow-sheet for the production of chocolate filled with fruits and oat

Then, the sensory properties of the obtained samples were evaluated by ten panelists to choose the best blends. The blends of roasted oats with mango pulp or strawberry pulp (T1, T2, T3, T6, T7 and T8) and raw materials were subjected to chemical and physical analysis as well as sensory and microbiological evaluation immediately after processing and periodically throughout storage period for six months at 5±2ºC.

Analytical methods

Proximate Analysis

Moisture, protein, fat, ash and crude fibre contents, pH and peroxide value were determined according to the methods of AOAC (2010). Total carotenoids were determined in the samples according to Askar and Treptow (1993). Non-enzymatic browning was determined according to the method of Rangana (1977). Total carbohydrates are given by difference according to the methods described by FAO, (2003). Total phenolic content was determined using Folin-Ciocalteu reagent as described by Singleton and Rossi (1965). While the ability of the extracts to scavenge 1,1-Diphenyl-2-picrylhydrazyl (DPPH) free radicals was determined by the method described by Brand-williams *et al*. (1995). The minerals content including calcium and potassium were determined using flame photometry while iron, content was determined by atomic absorption spectroscopy according to AOAC (2010). A standard colorimetric method was employed for phosphorus as mentioned by Borah *et al*. (2009). The content of anthocyanin was determined by the spectrophotometric method (Moor *et al*., 2005). β – glucan was determined according to the method described by Carr *et al*. (1990) and Bamforth (1983). Total calories of the filled chocolate were calculated by the formula of James (1995) as follows: Total calories (calories) = (Fat × 9) + (Protein × 4) + (Total carbohydrate× 4).

Microbiological analysis

Psychrophilic bacteria, molds and yeasts were determined according to APHA (American Public Health Association, 2001).

Sensory evaluation

Ten panelists evaluated the chocolate samples, using a 9-point Hedonic scale (Rosas-Nexticapa *et al*. 2005). The index of acceptance (IA) was calculated using the following equation: $IA = (M/9) \times 100$

Where M indicates the average of the evaluations carried out by sensory panel.

Statistical analysis

The results (mean± standard deviation) were statistically analyzed by analysis of variance (ANOVA) using the statistical package (Costat) software (version 6.311) according to Steel and Torrie (1980). To establish significant difference a significant level of P≤0. 05 was applied.

RESULTS AND DISCUSSIONS

The nutritional and sensory qualities of a food are related to its chemical, physical and biological factors (microbiological and enzymatic), from its manufacture to its consumption and hence information about the stability. The main characteristics of the raw materials can contribute to increase the use and improve the quality of the product (Gadani *et al*., 2017). Proximate chemical composition of mango pulp, strawberry pulp, roasted oat, white chocolate and skimmed milk powder constituents was significantly (p≤0.05) different. Table (2) showed that, the protein content of skimmed milk powder, roasted oat and white chocolate was (35.66, 11.98 and 8.11%) significantly higher than that for mango and strawberry pulp.

However, crude fibres and ash content of roasted oat were 3.41 and 1.86% these results agree with Biel *et al*. (2014) who reported that, crude fiber and ash content ranged from 2.28 to 3.64% and 1.73 to 1.99% of naked oat, respectively. As for crude fibres content, no significant differences (p≤0.05) could be observed between mango and strawberry pulp (4.35 and 4.76%). Meanwhile, skimmed milk and strawberry pulp contained higher content of ash 6.55 and 5.84%, respectively. Also, the obtained results showed that, fat content of white chocolate was the highest (33.82%) than the other ones.

The results in Table (2) revealed that, roasted oat had the highest content of phenolic compounds (195.11mg/100g) followed by strawberry pulp (125.86 mg/100g). Meanwhile, total carotenoids of mango pulp was 61.90 mg/100g, total anthocyanin of strawberry pulp was 65.21 mg/100g and β - glucan was 4.33 mg/100g for roasted oat. The DPPH assay is the most commonly used method for the evaluation of the antioxidant activity (AOA%). The antioxidant activity (AOA) of raw ingredients varied significantly (p≤ 0.05) and ranged from 14.69 to 75.11%, the highest and the lowest being observed for strawberry pulp and white chocolate, respectively (Table 2).

Table (2): Proximate chemical composition (mean±SD) of raw ingredients (on dry weight basis*)

Characteristics	Raw ingredients				
	Mango Pulp	**Strawberry pulp**	**Roasted oat**	**White chocolate**	**Skimmed milk**
Moisture%	64.56[b] ±0.28	72.52[a] ±0.33	9.75[c] ±0.41	1.67[e] ±0.15	3.68[d] ±0.44
***Protein%**	0.79[d] ±0.33	1.60[d] ±0.25	11.98[b] ±0.52	8.11[c] ±0.22	35.66[a] ±0.18
***Crude fibre%**	4.35[a] ±0.09	4.76[a] ±0.54	3.41[b] ±0.16	ND	ND
***Fat%**	1.04[c] ±0.12	1.25[c] ±0.16	2.47[b] ±0.35	33.82[a] ±0.14	1.33[c] ±0.12
***Ash%**	3.68[c] ±021	5.84[b] ±0.31	1.86[d] ±0.11	0.78[e] ±0.07	6.55[a] ±0.34
***Total carbohydrates %**	94.49[a] ±0.38	91.31[b] ±0.17	83.69[c] ±0.90	57.29[d] ±0.15	56.46[d] ±0.38
***Total phenolics mg/100g**	95.21[c] ±0.19	125.86[b] ±0.52	195.11[a] ±0.75	32.36[d] ±0.57	ND
***Total carotenoids mg/100g**	61.90[a] ±0.214	ND	ND	ND	ND
***Total anthocyanin mg/100g**	ND	65.21[a] ±0.56	ND	ND	ND
***β-Glucan mg/100g**	ND	ND	4.33[a] ±0.401	ND	ND
Antioxidant activity (DPPH, %)	56.12[b] ±0.24	75.11[a] ±0.16	21.20[c] ±0.97	14.69[d] ±0.49	ND

Means within a raw showing the same letters are not significantly different (P≤ 0.05)
ND: not determined

Chemical constituents of fruit filling blends

Data of the chemical composition of fruit filling blends are presented in Table (3). As for moisture content, there are significant differences (p≤0.05) between all blends where they ranged from 29.31 to 51.31% in all treatments. It was also found that, increasing addition of roasted oat from 13.3 to 39.3% and other powder ingredients in treatments led to decrease moisture content. A reverse trend was found for ash, since the replacement with roasted oat caused significant reduction.

Improved contents of protein and fat significantly increased (p≤0.05) from 5.84 to 10.15% and from 0.82 to 2.33% of all samples respectively, with the increased level of substitution of roasted oat. While, the replacement with roasted oat may be due to a significant decrease incrude fibres from 3.24 to 2.71%, ash from 4.63 to 2.75% and total carbohydrates from 87.01 to 82.06%.

Monitoring of pH in mixed filling fruit is important because the pH value is one of the sensitive factors that affect on quality and shelf life of the product. The addition of citric acid to the formulation was necessary to adequate the fruit mixture around to pH 4.0. Results in Table (3) showed that, the pH value ranged from 4.25 to 4.29 for T1, T2 and T3 and ranged from 3.92 to 4.04 for T6, T7 and T8.

The phytochemicals such as total phenolics, total carotenoids, and total anthocyanins of mixed filling fruit have been investigated and data are given in Table (3). It was observed that the total phenolics content (TPC) of mixed fruit filling blend significantly increased with increasing the roasted oat level, where they ranged from 54.65 to 93.26 mg/100g for T1, T2 and T3 and ranged from 92.02 to 122.03 mg/100g for T6, T7 and T8, respectively. The results confirmed previous studies; an increase in phenolic compounds after roast treatment has been reported by Pradeep and Guha (2011) who suggested increase in (TPC) during roasting due to the increase in the extractability of bound phenolics by the thermal degradation of cellular constituents. Meanwhile, total carotenoids and total anthocyanins significantly decreased with decreasing fruit pulp added where T1 and T6 had the highest content of total carotenoids, and total anthocyanins (41.26 and 42.46 mg/100gm, respectively).

The content of β - glucan of fruit filling blends was presented in Table (3). The β-glucan content of sample T1 was found to be 0.57 mg/100g significantly increased to 0.98 and 1.52 mg/100g of T2 and T3 with increasing oat levels added, where the β-glucan content of samples T6, T7 and T8 were found to be 0.52, 0.90 and 1.61 mg/100g, respectively.

The maintenance of antioxidant activity is important when developing new products. A significant increase in the antioxidant activity was observed when oat was added at 13.3 to39.9%. The differences between both formulae (T6 and T7) were not statistically significant. Recent investigation on the antioxidant activity indicated positive correlation between total phenolic compounds concentration and antioxidant activity. Lahouar *et al.* (2014) reported a significant positive correlation between the TPC and the antioxidant activity measured by DPPH assay.

Table (3): Chemical characteristics (mean ±SD) of fruit filling blends (on dry weight basis*)

Characteristics	Treatments					
	T1	T2	T3	T6	T7	T8
Moisture%	43.79[b] ±0.65	37.42[d] ±0.40	29.31[f] ±0.71	51.31[a] ±0.24	41.85[c] ±0.12	34.80[e] ±0.13
*Protein%	5.84[d] ±0.16	7.31[c] ±0.29	10.15[a]. ±0.19	6.24[d] ±0.14	7.61[c] ±0.16	9.71[b] ±0.37
*Crude fibre%	3.17[ab] ±0.18	3.24[a] ±0.18	2.71[c] ±0.21	2.86[bc] ±0.26	2.81[c] ±0.21	2.75[c] ±0.19
*Fat%	0.823[d] ±0.01	2.25[a] ±0.19	2.33[a] ±0.11	1.01[d] ±0.10	1.30[c] ±0.24	1.76[b] ±0.08
*Ash%	3.15[c] ±0.09	2.99[cd] ±0.15	2.75[d] ±0.22	4.63[a] ±0.15	4.57[a] ±0.26	3.68[b] ±0.13
*Total carbohydrates %	87.01[a] ±0.27	84.21[c] ±0.40	82.06[d] ±0.27	85.25[b] ±0.23	83.72[c] ±0.47	82.10[d] ±0.51
pH value	4.25[b] ±0.02	4.26[ab] ±0.02	4.29[a] ±0.01	3.92[d] ±0.03	3.94[d] ±0.03	4.04[c] 0.03
*Total phenolics mg/100g	54.65[f] ±0.85	75.65[e] ±0.22	93.26[c] ±0.47	92.02[d] ±0.39	113.38[b] ±0.42	122.03[a] ±0.40
*Total carotenoids mg/100g	41.26[a] ±0.39	34.29[b] ±0.72	25.62[c] ±0.60	ND	ND	ND
*Total anthocyaninmg/100g	ND	ND	ND	42.46[a] ±0.30	36.17[b] ±0.29	25.70[c] ±0.59
*β-Glucan mg/100g	0.57[d] ±0.04	0.98[c] ±0.07	1.52[b] ±0.04	0.52[d] ±0.01	0.90[c] ±0.02	1.61[a] ±0.07
Antioxidant activity (DPPH, %)	61.22[e] ±1.48	70.10[d] ±0.60	81.33[c] ±0.38	83.66[b] ±0.44	84.83[b] ±0.62	87.14[a] ±0.41

T1: 13.3% roasted oat + 66.5% mango pulp.T2: 26.5% roasted oat + 53.2% mango pulp.
T3: 39.9% roasted oat + 39.9% mango pulp. T6: 13.3% roasted oat + 66.5% Strawberry pulp.
T7: 26.5% roasted oat + 53.2% Strawberry pulp. T8: 39.9% roasted oat + 39.9% Strawberry pulp.
Means within a raw showing the same letters are not significantly different ($P \leq 0.05$).
ND: not determined.

Evaluation and characteristics of filled chocolate with fruit and roasted oat

Functional foods have gained prominence in the market, with a large number of products being developed (Morato *et al.*, 2015) and confectionery industry, especially cocoa and chocolate industries are undergoing dynamic changes in recent years, influenced by increased demands for healthy (Belscak-Cvitanovic *et al.*, 2015) or functional chocolates.

Filled chocolate was produced according to the standards for chocolate and chocolate products. Filled chocolate is a product covered by a coating of one or more of the chocolates. Filled chocolate does not include flour confectionery, pastry, biscuit or ice cream products. The chocolate part of the coating must make up at least 25% of the total weight of the product concerned (Codex, 2003a).

Proximate chemical composition and caloric value of filled chocolate prepared from different mixture are presented in Table (4). The significant difference ($p \leq 0.05$) was found between both filling mango and strawberry fruit blends in all chemical composition parameters. The moisture content of mango filling blend (TC1, TC2 and TC3) ranged from 21.98 to 27.44%, whereas strawberry filling blend (TC6, TC7 and TC8) had a moisture content ranged from 22.78 to 33.68%. The protein content in TC3 and TC8 was significantly higher than the other formulated treatments Table (4). These results are agreement with Paucean *et al.* (2015) who reported that, protein contents of snack-bars were significantly ($p \leq 0.05$) increased by increasing addition of oat flakes. According to Dietary Reference Intakes (DRI, 2002), the Recommended Dietary Allowances (RDA) of protein ranged from 34 to 56 g/day for age ranging from 9 - 70 years of both genders. The formulated filled chocolate 100g from TC2 and TC7 could provide average 23.38 and 23.85 %, respectively of the RDA of protein for adults.

Table (4): Proximate chemical composition (mean± SD) of filled chocolate (on dry weight basis*)

Characteristics	Treatments					
	TC1	TC2	TC3	TC6	TC7	TC8
Moisture%	27.44^{c} ±0.12	25.46^{d} ±0.33	21.98^{e} ±0.61	33.68^{a} ±0.52	28.76^{b} ±0.71	22.78^{e} ±0.63
*Protein%	7.06^{d} ±0.34	7.95^{c} ±0.15	10.41^{a} ±0.23	7.24^{d} ±0.52	8.11^{c} ±0.26	9.73^{b} ±0.13
*Crude fibre%	2.58^{a} ±0.12	2.44^{b} ±0.20	2.35^{c} ±0.15	2.47^{b} ±0.202	2.27^{c} ±0.110	2.08^{d} ±0.143
*Fat%	8.63^{c} ±0.12	9.59^{a} ±0.42	9.84^{a} ±0.17	9.23^{b} ±0.23	9.79^{a} ±0.13	9.93^{a} ±0.35
*Ash%	2.66^{d} ±0.20	2.12^{e} ±0.12	1.81^{f} ±0.19	4.02^{a} ±0.03	3.47^{b} ±0.19	3.04^{c} ±0.11
*Total carbohydrates %	79.07^{a} ±0.27	77.90^{b} ±0.21	75.59^{e} ±0.22	77.04^{c} ±0.18	76.36^{d} ±0.23	75.22^{e} ±0.57
Caloric value kcal /100 g	306.4^{d} ±2.67	319.6^{c} ±1.68	337.4^{a} ±2.52	278.7^{e} ±3.14	302.6^{d} ±2.82	331.5^{b} ±2.63
pH value	4.29^{b} ±0.05	4.31^{b} ±0.01	4.36^{a} ±0.01	3.89^{e} ±0.03	4.07^{d} ±0.02	4.10^{c} ±0.01
*Total phenolics mg/100g	44.91^{f} ±0.16	62.04^{e} ±0.27	74.51^{d} ±0.11	81.69^{c} ±0.34	88.63^{b} ±0.48	95.92^{a} ±0.39
*Total carotenoids mg/100g	33.44^{a} ±0.31	28.48^{b} ±0.48	20.67^{c} ±0.19	ND	ND	ND
*Total anthocyanin mg/100g	ND	ND	ND	31.37^{a} ±0.22	26.59^{b} ±0.32	22.29^{c} ±0.16
*β-Glucan mg/100g	0.48^{d} ±0.02	0.68^{c} ±0.06	1.44^{a} ±0.02	0.42^{e} ±0.02	0.65^{c} ±0.02	1.17^{b} ±0.03
Antioxidant activity (DPPH, %)	56.32^{e} ±0.84	62.11^{d} ±0.47	72.12^{c} ±0.92	78.32^{b} ±0.99	79.18^{b} ±0.21	81.46^{a} ±0.49

TC1: 13.3% roasted oat + 66.5% mango pulp. TC2: 26.5% roasted oat + 53.2% mango pulp.
TC3: 39.9% roasted oat + 39.9% mango pulp. TC6: 13.3% roasted oat + 66.5% Strawberry pulp.
TC7: 26.5% roasted oat + 53.2% Strawberry pulp. TC8: 39.9% roasted oat + 39.9% Strawberry pulp.
Means within a raw showing the same letters are not significantly different (P≤ 0.05).
ND: not determined.

In the same trend, crude fat content ranged from 8.63 to 9.84% in (TC1 to TC3) and from 9.23 to 9.93% in (TC6 to TC8). Meanwhile, no significant difference (p≤ 0.05) has been found between (TC2 and TC3) and (TC7 and TC8). Coating with white chocolate increased the crude fat content in all treatments. In context, the Recommended Daily Allowance (DRI, 2002) of fat for the average adult is 25 to 35 g/day. Consuming about 100 g/day filled chocolate TC2 and TC7 could provide average 38.36 and 39.16 %, respectively of the RDA of fat for adults.

Data in the same Table (4) showed that, the crude fibres content ranged from 2.35 to 2.58% in (TC1 to TC3) while it ranged from 2.08 to 2.47% in (TC6 to TC8). Similarly the results observed that, the highest ash content found in both TC1 (Mango blend) and TC6 (Strawberry blend) than the all treatments. The RDA (DRI, 2002) of fibre for the average adult is 21 to 31 g/day. Consuming about 100 g/day filled chocolateTC2 and TC7 could provide average 11.62 and 10.80%, respectively of the RDA of fibre for adults.

The caloric value ranged from 306.4 to 337.4 kcal/100g in TC1 to TC3 and from 278.7 to 331.5 kcal/100g in TC6 to TC8 calculated on (FW), respectively. Accordingly, as shown 100g/day of filled chocolate (TC2 and TC7) could provide about 319.6-302.6 kcal, respectively which is cover adult person (70 kg, 2000 kcal) requirements for about 15.98 and 15.13% of daily caloric needs dietary reference intakes (DRI, 2002).

Oats being a good source for soluble dietary fiber β- glucan and unsaturated fatty acids, also contain bioactive phytochemicals such as vitamins, minerals, phenolic acids, and avenanthramides (Welch, 2011). The total phenolic compounds and β- glucan content of all treatments significantly increased (p≤0.05) by roasted oat addition (Table 4). The major contribution of roasted oat as ingredient is that it has higher amount of total phenolic compounds and β- glucan content. The amounts of total phenolic compounds and β-glucan content after addition of roasted oat were correlated to percent addition, also the differences among the formulations were significant. The results observed that, TC3 and TC8 had highest content than other treatments in total phenolic compounds and β- glucan contents. β-glucan is found to be effective in reducing serum cholesterol concentration and postprandial blood glucose level (Tiwari and Cummins, 2009) and has good water binding and emulsion stabilizing properties, thus it has been used in different food products to improve the rheological properties (Lazaridou and Biliaderis, 2007).

From the same Table (4), it could be observed that, the addition of roasted oat cause a significant reduction of total carotenoids and total anthocyanins from 33.44 mg/100g in TC1 to 20.67 mg/100g in TC3 and from 31.37 mg/100g in TC6 to 22.29 mg/100g in TC8, respectively. The antioxidant activity of various treatments was assayed using the common DPPH given in Table (4). The antioxidant activity significantly increased ($p\leq 0.05$) from 56.32 to 72.12% in filled chocolate with mango concentrate and from 78.32 to 81.46% in filled chocolate with strawberry concentrate, respectively. These results are in agreement with Al-Laith (2010). The antioxidant activity attributed to the presence of phenolic compounds.

Minerals content of filled chocolate

Mineral elements as inorganic ions and salts, as well as part of organic molecules, such as proteins, fats, carbohydrates and nucleic acids. The chemical form of mineral elements is important because it determines their absorption in the intestine and their biological utilization. The content of minerals such as calcium, phosphorus, potassium and iron in filled chocolate presented in Table (5). Data showed that, increasing the roasted oat level from 13.3 to 39.9% caused increment in phosphorus, iron and calcium content in all filled chocolate treatments. On the other hand, potassium content decreased. This is due to the higher content of oat in phosphorus and iron content as compared to mango and strawberry fruits. Meanwhile, potassium content decreased by decreasing the fruit level from 66.5 to 39.9% in filled chocolate treatments. Hu *et al.* (2014) reported that, the mineral contents of naked oat flakes from different countries ranged from 27.20 to 109.82 mg/100g for calcium and 1.29 to 5.54 mg/100g for iron, while, phosphorus and potassium contents were 523.0 and 429 mg/100 g, respectively (USDA, 2016).

Table (5): Minerals content (mg/100g) of filled chocolate (on dry weight basis)

Minerals content	TC1	TC2	TC3	TC6	TC7	TC8
Calcium (Ca)	63.39	65.95	68.50	73.62	74.13	74.63
Phosphorus (P)	82.48	112.09	141.69	85.41	114.43	143.45
Potassium (K)	258.23	247.08	235.93	282.50	266.49	250.49
Iron (Fe)	0.53	0.84	1.16	1.38	1.53	1.67

TC1: 13.3% roasted oat + 66.5% mango pulp. TC2: 26.5% roasted oat + 53.2% mango pulp.
TC3: 39.9% roasted oat + 39.9% mango pulp. TC6: 13.3% roasted oat + 66.5% Strawberry pulp.
TC7: 26.5% roasted oat + 53.2% Strawberry pulp. TC8: 39.9% roasted oat + 39.9% Strawberry pulp.

The Recommended Dietary Allowances (RDA) for, calcium (550-1000), phosphorus (450-775), potassium (2000-3500) and iron (8.7-14.8) mg/day. For consumer body requirements, the presented minerals content in 100g/day filled chocolate TC2 and TC7 could provide average 11.99, 13.48; 24.91, 25.43; 12.35, 13.32 and 9.66 and 17.58%, respectively of the RDA for adults from the daily allowances intakes of Ca, P, K and Fe mg/day, respectively. So the filled chocolate TC2 and TC7 are good source of some minerals and responsible for providing a quantity of the human requirements. Munhoz *et al*. (2014) reported that, a food is considered a source of minerals when has at least 15% of recommended daily intake (RDI) referring to 100 g of food.

Effect of storage period for six months at 5±2ºC on characteristics of filled chocolate

Confectionery product is usually stored for long periods. Exposed to air and light, taste can deteriorate. Therefore aluminium foil is frequently used to provide a barrier for light, moisture and other gas, oxidation and any penetration of unwanted aroma and flavor (Busser and Jungbluth, 2009).

Color index of filled chocolate

There is no doubt that food color is among the most important factors affecting its quality and hence its palatability among the majority of consumers. Change in color especially these associated with deterioration in quality or with spoilage, cause the product to be rejected by the consumer (Mohamed *et al*., 2008).From Table (6), it could be noticed that, color intensity of the samples stored at 5±2°C showed significant increase ($p\leq 0.05$) during 6 months of storage. At the end of the storage period, a significant increase ($p\leq 0.05$) of color index in all treatments. However, there were no significant differences in color index was observed for TC3 and TC7 after three and six months of storage.

Meanwhile, the samples TC1, TC2 and TC3 showed significant differences in color intensity when compared with each other at the end of the storage period. These results agree with Rossini *et al*. (2011) who reported that, the development of browning index in white chocolate is mainly due to the non-enzymatic browning reactions and the ambient conditions during the storage period.

Table (6): Effect of storage period at 5±2 ºC on color index (OD at 420 nm) of filled chocolate

Storage periods month	TC1	TC2	TC3	TC6	TC7	TC8
0	0.201^{aB} ±0.015	0.185^{aAB} ±0.010	0.168^{aA} ±0.023	0.250^{aB} ±0.019	0.199^{aA} ±0.015	0.187^{aA} ±0.024
3	0.262^{bC} ±0.016	0.200^{abB} ±0.011	0.177^{bA} ±0.021	0.277^{bC} ±0.023	0.217^{abB} ±0.016	0.195^{aA} ±0.018
6	0.289^{cC} ±0.019	0.220^{cB} ±0.006	0.184^{bA} ±0.019	0.301^{cB} ±0.014	0.234^{bA} ±0.026	0.239^{bA} ±0.036

TC1: 13.3% roasted oat + 66.5% mango pulp. TC2: 26.5% roasted oat + 53.2% mango pulp.
TC3: 39.9% roasted oat + 39.9% mango pulp. TC6: 13.3% roasted oat + 66.5% Strawberry pulp.
TC7: 26.5% roasted oat + 53.2% Strawberry pulp. TC8: 39.9% roasted oat + 39.9% Strawberry pulp.
Means within a column a, b, c showing the same letters are not significantly different (P≤ 0.05) for storage.
Means within a raw A, B, C showing the same letters are not significantly different (P≤ 0.05) for treatments.

Peroxide value of filled chocolate

Peroxide value is a common parameter to characterize oils and fats, since its values indicate high degradation and oxidation of them. The lipid oxidation reactions are the main cause of deterioration of oils and fats and develop from the interaction of unsaturated fatty acids and oxygen with subsequent formation of peroxides which can be converted to secondary and stable products such as aldehydes, ketones, alcohols, hydrocarbons, esters, furans and lactones, which alter the physical and chemical properties and impact negatively on the taste and odor of food (Farhoosh *et al*., 2009; Alencar *et al*., 2010).

Table (7): Effect of storage period at 5±2 ºC on peroxide value (meq/kg) of filled chocolate

Storage periods month	TC1	TC2	TC3	TC6	TC7	TC8
0	0.78^{aB} ±0.03	0.72^{aB} ±0.06	0.55^{aA} ±0.04	0.84^{aC} ±0.03	0.75^{aB} ±0.05	0.63^{aA} ±0.04
3	1.18^{bC} ±0.03	1.08^{bB} ±0.01	0.91^{bA} ±0.06	1.21^{bB} ±0.02	1.15^{bB} ±0.04	0.91^{bA} ±0.05
6	1.28^{cC} ±0.03	1.18^{cB} ±0.03	1.03^{cA} ±0.04	1.29^{cB} ±0.02	1.23^{cB} ±0.05	0.99^{cA} ±0.03

TC1: 13.3% roasted oat + 66.5% mango pulp. TC2: 26.5% roasted oat + 53.2% mango pulp.
TC3: 39.9% roasted oat + 39.9% mango pulp. TC6: 13.3% roasted oat + 66.5% Strawberry pulp.
TC7: 26.5% roasted oat + 53.2% Strawberry pulp. TC8: 39.9% roasted oat + 39.9% Strawberry pulp.
Means within a column a, b, c showing the same letters are not significantly different (P≤ 0.05) for storage.
Means within a raw A, B, C showing the same letters are not significantly different (P≤ 0.05) for treatments.

Data in Table (7) showed that, the peroxide values of filled chocolate packed in aluminium foil were relatively low. The data found that there were significant increased (p≤0.05) in peroxide values for all treatments at the end of storage period. Meanwhile TC3 and TC8, were the lowest samples in peroxide values (1.03 and 0.99 meq/kg) compared with each other treatments (TC1and TC2; TC6 and TC7), respectively and do not undergo rancidity. These results are in agreement with Karwowska and Dolatowski (2007) who demonstrated that, the greater addition of roasted oat resulted in a higher stability of the products during their chill storage. The oat-supplemented products were characterized by a lower degree of lipid oxidation and more stable color in reference to the control product. Meanwhile, Alencar *et al*. (2010) reported that, the product with a peroxide index between 1 and 5 meq/kg is classified at low oxidation state; that between 5 and 10 meq/kg get moderate oxidation, and above 10 meq/kgis classified at a high oxidation state. Thus, the products of our study were not considered to have high peroxide indices during storage period. Also, packages with lower oxygen and moisture permeability, such as aluminium foil minimized such changes, being therefore the most suitable for long-term storage (Gadani *et al*., 2017).

Microbial population of filled chocolate

In addition to nutritional value, the microbiological quality of food items is essential to of consumer health and safety. The filled chocolate developed were evaluated according to microbiological quality parameters before the sensory evaluation were carried out. The microbiological quality of the samples was satisfactory, in accordance with the requirements of (Codex, 2003b; FDA, 2013), which describes the microbiological count that must be verified in filled chocolate products. The stored filled chocolate packed in aluminium foil were evaluated for the presence of viable microbial counts immediately after processing and during storage for 6 months under cold conditions (5±2ºC) is presented in Table (8).The microbial evaluation including psychrophilic bacteria and yeast and mold counts in the sample after processing in zero time.

Table (8): Effect of storage period at 5±2 ºC on microbial count (log CFU/g) of filled chocolate

Storage periods month	Psychrophilic bacteria					
	TC1	TC2	TC3	TC6	TC7	TC8
0	1.83^{aA}	1.77^{aA}	1.75^{aA}	1.92^{aB}	1.88^{aB}	1.77^{aA}
3	2.14^{bB}	2.01^{bAB}	1.91^{abA}	2.20^{bB}	2.13^{bAB}	1.99^{bA}
6	2.30^{bB}	2.20^{cB}	1.97^{bA}	2.35^{bB}	2.28^{cB}	2.12^{bA}
	Yeast and mold					
0	1.68^{aB}	1.56^{aAB}	1.45^{aA}	1.70^{aB}	1.61^{aA}	1.58^{aA}
3	2.01^{bA}	1.82^{bA}	1.84^{bA}	2.16^{bA}	2.05^{bA}	2.04^{bA}
6	2.35^{cB}	2.37^{cB}	2.21^{cA}	2.53^{cB}	2.50^{cB}	2.26^{cA}

TC1: 13.3% roasted oat + 66.5% mango pulp. TC2: 26.5% roasted oat + 53.2% mango pulp.
TC3: 39.9% roasted oat + 39.9% mango pulp. TC6: 13.3% roasted oat + 66.5% Strawberry pulp.
TC7: 26.5% roasted oat + 53.2% Strawberry pulp. TC8: 39.9% roasted oat + 39.9% Strawberry pulp.
Means within a column a, b, c showing the same letters are not significantly different (P≤ 0.05) for storage.
Means within a raw A, B, C showing the same letters are not significantly different (P≤ 0.05) for treatments.

The low of microbial counts was because of the severity of thermal treatment during processing, thus all concentrated fruit pulp were pasteurized, also the safety and hygiene procedures follows throughout the formulation and procedure process. Also, this might be due to the preservative effect used like sodium benzoate and potassium sorbate has been demonstrated to be able to inhibit the growth of moulds, yeasts and some bacteria. Moreover, laminated aluminium foil seemed to be the best material to inhibit growth of the mesophilic bacteria, moulds, and yeasts (Lemuel *et al*., 2014). Limited microorganism counts were detected even after 3 and6 months of storage for samples stored under cooling conditions. Nonetheless, in the microbiological evaluation, all filled chocolate samples have met the standards set by the legislation, being suitable for consumption and below the permissible limits (10^3/g and 10^4/g) set by (Codex, 2003b and FDA, 2013) and the International Commission for Microbial Specifications for foods.

Sensory analysis of filled chocolate.

The main challenge of food industry is to comply with consumers' expectations that hold high standards for the foods they consume. They demand foods that taste great, are fat- and/or calorie-reduced, and they are interested in foods that provide added health benefits. These foods must be convenient and affordable (Golob *et al*., 2004). The average scores obtained by the six filled chocolate formulations in the sensory evaluation are demonstrated in Table (9). All formulations had good sensory acceptability in attributes color, taste, texture and overall acceptability. The mean scores attributed by pane lists were higher than 6 in all evaluated sensory attributes.

During storage, a significant degradation (p ≤ 0.05) in sensory quality was observed (Table 9), with regard to the color, there were no significant differences (p≤0.05) among the six formulations of filled chocolate samples at zero time. This result indicates that, the higher level of roasted oat in the formulations did not contribute to noticeable differences in product color.

The taste attribute showed statistically significant differences (p ≤ 0.05) among TC1, TC2 and TC3 while, no significant differences in taste of filled chocolate with strawberry fruit formulations. Also, the texture of filled chocolate treatments TC2 and TC7 had highest score than other ones, followed by TC1, TC6, TC3 and TC8 recorded the lowest scores. On the other hand, analysis of variance (ANOVA) of the data indicated no significant differences (p≤0.05) among the samples in overall acceptability (Table 9), with formulation TC2, TC1 and TC7, TC6 obtaining the highest scores. Comparing samples TC6 and TC8, it is seen that there were no statistically significant differences among the formulations. The sensory analysis results suggest that the increased concentration of roasted oat in the filled chocolate formulations contributed to the slight reduction in taste acceptance and texture, but does not influence color of these formulations. From the index of acceptance (IA), formulations TC2 and TC7 has the best acceptance 91.8 and 90.4%, respectively compared to the other formulations. In fact, all the formulae showed an index of acceptance above 70%, except TC3 obtained 69.3% at the end of storage periods.

Table (9): Effect of storage period at 5±2 ºC on sensory characteristics of filled chocolate

Storage period months	TC1	TC2	TC3	TC6	TC7	TC8
			Color			
0	8.2^{aA}	8.0^{aA}	7.8^{aA}	8.1^{aA}	8.0^{aA}	7.7^{aA}
3	7.9^{abA}	7.7^{abAB}	7.2^{aBC}	7.6^{abAB}	7.9^{aA}	6.8^{bC}
6	7.6^{bA}	7.3^{bA}	6.5^{bB}	7.1^{bAB}	7.7^{aA}	6.5^{bB}
			Taste			
0	8.0^{aA}	8.1^{aA}	7.2^{aB}	8.0^{aA}	8.1^{aA}	7.7^{aAB}
3	7.6^{aA}	7.2^{bA}	6.3^{bB}	7.5^{abA}	7.8^{aA}	7.5^{abA}
6	7.4^{aA}	6.9^{bA}	6.1^{bB}	7.1^{bA}	7.5^{aA}	7.0^{bA}
			Texture			
0	8.0^{aAB}	8.4^{aA}	7.6^{aB}	7.8^{aAB}	8.3^{aA}	7.4^{aB}
3	7.1^{bABC}	7.5^{bA}	6.7^{bBC}	6.6^{bC}	7.3^{bAB}	6.7^{abBC}
6	6.7^{bAB}	7.2^{bA}	6.1^{bB}	6.0^{bB}	7.0^{bA}	6.1^{bB}
			Overall acceptability			
0	8.1^{aA}	8.2^{aA}	7.5^{aC}	8.0^{aAB}	8.1^{aA}	7.6^{aBC}
3	7.5^{bAB}	7.5^{bAB}	6.7^{bD}	7.2^{bBC}	7.7^{bA}	7.0^{bCD}
6	7.2^{bA}	7.1^{bAB}	6.2^{cD}	6.7^{cBC}	7.4^{bA}	6.5^{cCD}
			Index of acceptance (IA) %			
0	89.6^{aA}	91.8^{aA}	83.7^{aC}	88.5^{aAB}	90.4^{aA}	84.3^{aBC}
3	83.7^{bAB}	83.0^{bAB}	74.8^{bD}	$80.^{4bBC}$	85.0^{bA}	77.8^{bCD}
6	80.4^{bA}	79.3^{bAB}	69.3^{cD}	74.8^{cBC}	82.2^{bA}	72.6^{cCD}

TC1: 13.3% roasted oat + 66.5% mango pulp. TC2: 26.5% roasted oat + 53.2% mango pulp.
TC3: 39.9% roasted oat + 39.9% mango pulp. TC6: 13.3% roasted oat + 66.5% Strawberry pulp.
TC7: 26.5% roasted oat + 53.2% Strawberry pulp. TC8: 39.9% roasted oat + 39.9% Strawberry pulp.
Means within a column a, b, c showing the same letters are not significantly different (P≤ 0.05) for storage.
Means within a raw A, B, C showing the same letters are not significantly different (P≤ 0.05) for treatments.

CONCLUSION

Finally, it could be concluded through this study, that it is successful practicable and applicable to produce new untraditional chocolate filled with fruits and oat with ratios of 53.2: 26.6%. Those aforementioned products will help to produce healthy and high nutritional value products instead of artificial ones which have been proved to be harmful to human health especially who are considered the first consumers of those investigated products.

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تقييم شوكولاتة جديدة غير تقليدية محشوة ببعض الفواكه والشوفان

أيمن سيد دياب

قسم بحوث تكنولوجيا الحاصلات البستانية - معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية - جيزة - مصر

مما لا شك فيه أن العديد من الأطفال والبالغين يعانون من أمراض سوء التغذية. بالإضافة إلى إستهلاكهم الزائد من الأغذية المرتفعة في نسبة الدهون والسكريات، التي تؤدي إلى العديد من الأمراض وبخاصة السمنة. لذا يهدف هذا البحث إلى إنتاج منتجات جديدة من الشوكولاتة المحشوة بلب الفاكهة والشوفان والمقبولة حسياً وصحياً والتي تمتاز بإحتوائها على الألوان والنكهة الطبيعية بدلاً من تلك الصناعية الضارة بالصحة. وأظهرت النتائج المتحصل عليها أن زيادة نسبة الإضافة من الشوفان المحمص أدت إلى زيادة محتوى كل من البروتين، الدهون، الفينولات الكلية، البيتاجلوكان وزيادة النشاط المضاد للأكسدة وإنخفاض كل من الألياف، الرماد، الكربوهيدرات الكلية، الكاروتينات الكلية ومحتوى الأنثوسيانين. كما تشير النتائج المتحصل عليها أن (١٠٠ جم) من الشوكولاتة المحشوة يمكن أن توفر ٢٣.٣٨ إلى ٢٣.٨٥% من الإحتياجات اليومية الموصى بها للبالغين من البروتين، كما تعتبر مصدراً جيداً لتوفير جزء من الإحتياجات اللازمة لجسم الإنسان من الفوسفور والحديد. كما تم دراسة تأثير التخزين المبرد على درجة حرارة (٥°م ± ٢) لمدة ستة أشهر على كل من كثافة اللون، رقم البيروكسيد، الخصائص الميكروبيولوجية والتقييم الحسي للشوكولاته المحشوة. أوضحت النتائج المتحصل عليها زيادة قيم كثافة اللون ورقم البيروكسيد زيادة معنوية خلال فترات التخزين في حين أن زيادة مستوى الإضافة من الشوفان المحمص أسفرت عن ثبات أعلى للمعاملات حتى نهاية فترة التخزين. وفي الوقت نفسه كانت الخصائص الميكروبيولوجية للشوكولاته المحشوة بالفاكهة والشوفان المحمص أقل من الحدود المسموح بها. وحازت معاملات الشوكولاتة المحشوة بلب الفاكهة والشوفان المحمص على قبول حسي مرتفع. أما بالنسبة لمؤشر القابلية العامة، حازت المعاملتان ت ٢ و ت ٧ المحتويتان على ٥٣.٢ : ٢٦.٦% (مركز لب المانجو أو الفراولة : الشوفان المحمص) على أفضل نسب قبول ٩١.٧٧ و ٩٠.٣٣% على التوالي بالمقارنة مع باقي المعاملات.

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