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Evaluation of Organoleptic, Physical Properties and Proximal Composition of Some Bakery Products Prepared with Yellow Sweet Potato

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Abstract: Sweet potatoes are relatively inexpensive, it are rich in complex carbohydrates, dietary fiber and beta-carotene, while having moderate contents of other micronutrients, including vitamin B_5, vitamin B_6 and manganese. This work was done to prepare some bakery products (cupcakes and biscuits) using different proportions of yellow sweet potato flour as replacement of wheat flour. Evaluate the products quality through organoleptic and objective evaluations and proximal composition. Cupcakes and biscuits were prepared using 10, 20 and 30% yellow sweet potato flour as replacement of wheat flour. The final product was evaluated physically and sensory by untrained panelists. In addition to determine chemical composition of moisture, ash, total proteins, fat and carbohydrates. The obtained results revealed that incorporation of 20% sweet potato flour in baked cupcakes and biscuits yielded slight reduction in weight, height, volume and density values as compared to those prepared with 100% wheat flour (control). Baked cupcakes with 20% sweet potato flour have the highest acceptable scores of panelists for sensory properties of exterior color, taste, sweetness, odor and general acceptability as compared to control. Baked biscuits with 30% sweet potato flour have the higher scores of exterior color, taste, sweetness, crispy and general acceptability as compared to control. In addition, baked products with different levels of sweet potato flour improved the nutritive values of ash and total carbohydrate and had slight reduction in total moisture, protein and fats as compared to that baked using 100% wheat flour. In conclusion, blending sweet potato flour with wheat flour up to 20% and 30% for baked cupcakes and biscuits, respectively produces higher acceptable and nutritive value and improved functional properties.

Key words: Yellow Sweet Potato · Organoleptic Characteristic · Proximate composition · Baked Product

INTRODUCTION

Sweet potato (*Ipomoea batatas)* currently ranks as the most important food crop on a fresh-weight basis in developing countries after rice, wheat, maize and cassava. Among the root and tuber crops, it is the only one that has a positive per capita annual rate of increase in production in sub-Saharan Africa [1]. The Sweet potato is an economical and healthful food crop containing beta-carotene and substantial amounts of ascorbic acid and minerals [2]. It has a large potential to be used as a food in developing nations with limited resources because of its short maturity time and ability to grow under diverse climatic condition and on less fertile soil [3]. Sweet potato flour can serve as a source of energy and nutrients and can add natural sweetness, color, flavor and dietary fiber to processed food products [2]. Sweet potatoes are relatively inexpensive and have several health benefits. Besides simple starches, it is rich in complex carbohydrates, dietary fiber and beta-carotene, while having moderate contents of other micronutrients, including vitamin B_5, vitamin B_6 and manganese. They

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contain substantial amounts of phytoene, phytofluene and vitamin C. β-carotene [4]. In addition to nutritive value, carotenoids have antioxidant activity and have been studied for potential health benefits such as reducing the risk of cancers, decreasing hypertension and decreasing inflammatory [5].

Bakery products such as cakes and biscuits have high consumer acceptance and are important for delivering bioactive compounds into the human diet [6]. Although cakes and/or biscuits are not considered basic food, such as bread, they are accepted and consumed by people of different ages [7]. Cakes have enjoyed are relatively constant place in our diet for a long time. It is often a dessert of choice for meals at ceremonial occasions [8]. Biscuits are nutritive snacks produced from unpalatable dough that is transformed in appetizing product through the application of heat in an oven [9]. They are ready-to-eat convenient and inexpensive food product containing digestive and dietary properties of vital importance [10]. Due to the new trends for healthy products suitable for children, adults this study was conducted to obtain cupcakes and biscuits acceptable in organoleptic and physical properties as well as richer in nutritive value by the addition of yellow sweet potato flour at different levels.

MATERIALS AND METHODS

Materials

Yellow Sweet Potato: Fresh yellow sweet potato was purchased from the local market, Makka, KSA.

Ingredients for Cupcakes and Biscuits Preparation: Wheat flour, sucrose, butter eggs, milk, vanillin, baking powder and other ingredients for cupcake and biscuits preparation were purchased from the local market, Makka, KSA.

Methods

Preparation and Drying of Sweet Potato: Sweet potato (SP) tubers were soaked in tap water for 15 min and cleaned to remove adhering soil particles and other foreign debris and sorted to remove small and injured roots. The roots were cut into small slices and rinsed for blanched at hot distilled water (80°C for 2min) immediately after cutting to controlling the browning reactions. Afterwards, it was dried by cotton cloth to remove the excess liquid prior to drying. Drying was achieved by using under vacuum oven at 55 - 60 °C as described by Thao and Noomhorm [11]. Grinder mill and sieves were used to obtain a powder particle size of less than 0.2mm to obtain yellow sweet potato flour (SPF) for used in the fortified products.

Preparation of Cupcakes: Cupcakes were prepared following a standard formulation (100% wheat flour) and partial replacement of the three different levels of SPF (10, 20 and 30%) as substitute of wheat flour (WF) according to the described method by Moraes *et al.,* [12]. Then cake dough was weight and put in a cupcake container and baked in an oven at 180°C for 25 minutes. Ingredients of cupcakes with 100% WF and/or a partial replacement of wheat flour by SPF are presented in Table 1.

Preparation of Biscuits: Biscuits were prepared with 100% WF (control) and with different levels (10%, 20% and 30%) of SPF as replacement of WF as described by Brennan and Samyue [13] with some modifications. The developed dough were put in refrigerator for 10 min., then flattened manually using wooden roller to about 0.5 cm in thickness, cut in to spherical and baked in an warm oven at 180°C. Ingredients for biscuits preparation with WF or a partial replacement of WT by SPF are shown in Table 2.

Evaluation of Cupcakes and Biscuits:

Physical properties: Physical properties were done on control and fortified cupcakes and biscuits, after cooling for at least two hours. Evaluation parameters included percentage change in weight after baking, height, volume and density, while index to volume was estimated for cupcakes only.

Baked products were weight before and after baking and the change in the products weight (g) was calculated and represented as percent using the following equation:

% change in weight= Weight before baking (g) - Weight after baking (g)/Weight after baking (g)

Products height (cm) and volume (cm^3) were determined by using the method of seed replacement as described by Penfield and Campbell [14]. Density of cupcakes and biscuits was done by using the following equation:

Density = Weight (g)/ Volume (cm^3)

Organoleptic properties: Prepared baked products with WF only and with different percentages of SPF were subjected to sensory evaluation by twenty untrained panelists from staff members, employers and students at the college of Applied Medical Sciences using score sheet according to the method by Meilgaard *et al.* [15]. In initial evaluations, panelists were asked to evaluate final products characteristic (appearance, exterior and interior color, taste, degree of sweetness, odor, cell uniformity, tenderness and overall acceptability). The obtained results were calculated as means, analyzed statistically and tabulated in comparison to control.

Proximal composition: Cupcakes and biscuits were subjected to chemical analysis to determine proximal composition including moisture content, ash, total protein, fat and carbohydrates.

Moisture content of cupcakes and biscuits was determined by weighing them before and after complete desiccation of samples at 103±3 °C in a hot air oven for 24hr according to the method described by Fennema *et al.* [16]. Ash was determined in the samples of cupcakes and biscuits using Muffle Furnace at 550 °C according to AOAC [17]. Samples were weighed in ash dish which has been ignited in Muffle until light gray ash was obtained and allowed to cool in desiccators and weighed at room temperature.

The total protein content of samples was determined on the basis of total nitrogen content using Kjeldahel apparatus according to the described method by AOAC [17]. Total fat content of the samples were determined by using Soxhalet apparatus (Hexan solvent) according to the described method by AOAC [17].The total carbohydrate was calculated by difference.

Statistical Analysis: The results were expressed as mean±SD and statistical significance was assessed using one-way analysis of variance (ANOVA) test. Statistical analyses were performed using the SPSS software (Statistical Package for the Social Sciences, version 16.00, Chicago, USA).

RESULTS

The prepared baked products with different levels of SPF were evaluated physically and sensory and its proximal composition to determine the best level of SPF that maintained better properties and acceptability to the final products.

Cupcakes

Physical Properties: Results of physical properties for baked cupcakes with WF only and different levels of SPF are recorded in Table 3. The present data indicated that baked cupcakes with different levels of sweet potato flour had lower values as percentage of weight and volume as compared to that prepared with 100% wheat flour (control). With regard to the effect of incorporated SPF in cupcakes as replacement of WF on height and density values, the results revealed that there were no changes in the percentage relative to control values of height and density for cupcakes prepared with 10% of SPF, while percentage relative to control values were higher in cupcakes prepared with the highest level of SPF as compared to the control.

Organoleptic Properties: Results of organoleptic evaluation for cupcakes prepared without (100% WF) and different levels (10, 20 and 30%) of SPF are presented in Table 4. Data indicated that baked cupcakes with different levels of SPF had no significant changes in appearance, taste and tenderness scores as compared to that of control (100% WF).

With regard to exterior color, results showed that baked cupcakes with 10 and 30% sweet potato flour had no significant changes compared to that of cupcakes prepared with 100% WF (control). The higher score for exterior color was showed in cupcakes prepared with 20% SPF, which was significantly increased compared to that of baked cupcakes with 100% WF.

Prepared cupcakes with 10, 20 and 30% of SPF have significantly lower scores for interior color at $p<0.05$ as compared to that prepared without SPF. Prepared cupcakes with 10, 20 and 30% of SPF had significant increase in scores of sweetness compared to that of prepared cupcakes with 100% WF. The higher score of sweetness was showed in prepared cupcakes with 30% sweet potato compared to that prepared with the other levels.

Means±SD scores of odor for prepared cupcakes with 10 and 30% sweet potato were not significantly increase at $p<0.05$ compared to that of control. The higher

score of odor was found in cupcakes prepared with 20% of SPF which was significantly changed compared with that of prepared cupcakes with 10 and 30% and control (100% WF). Cell uniformity scores of prepared cupcakes with 10 and 20% of SPF were not significant changed at $p<0.05$ compared to that baked cupcakes with 100% WF. In contrast, backed cupcakes with 30% SPF had significant lower scores compared to that of backed with 10 and 20% SPF and 100% WF.

With regard to the general acceptability of baked cupcakes, the present data indicated that the higher acceptable score was found for baked cupcakes with 20% of SPF which was significantly increase at $p<0.05$ compared to that of control (100% WF). In contrast, the lowest score was showed for baked cupcakes with 30% SPF compared to that of control.

Major Proximate Composition: Data of chemical composition for baked cupcakes with 100% WF and that prepared with three different levels of SPF as replacement of wheat flour are recorded in Table 5. It demonstrated that prepared cupcakes with the different levels of SPF had the lowest values of moisture, total protein and total fat as compared to that prepared with 100% WF. In contrast, higher values of ash and total carbohydrate content was found in baked cupcakes with the different levels of sweet potato as compared to that prepared with 100% WF.

Biscuits

Physical Properties: As shown in Table 6, recorded data indicated that weight (g), volume (cm^3) and density (g/cm^3) values of baked biscuits with 10% SPF were similar that of that baked with 100% WF (control). However, baked biscuits with the levels of 20 and 30% SPF had slight decrease in the values of weight (g), volume (cm^3) and density (g/cm^3) as compared to that of control.

Thickness values (cm) of prepared biscuits with the 10, 20 and 30% SPF as replacement of WF were slight decrease as compared to that prepared biscuits with 100% WF.

Organoleptic Properties: Results of sensory evaluation for baked biscuits with 100% WF and those prepared with 10, 20 and 30% SPF as replacement of WF are presented in Table 7. It revealed that Means±SD scores of

Table 1: Ingredients of cupcakes prepared with WF only and SPF.

		Preparation with using SPF		
Ingredients	Preparation with 100% WF (Control)	10%	20%	30%
WF (g)	220	198	176	154
SPF (g)	0	22	44	66
Sucrose (g)	120	120	120	120
Butter (g)	110	110	110	110
Eggs (g)	135	135	135	135
Milk (ml)	120	120	115	115
B.P	10	10	10	10
Vanillin (g)	10	10	10	10
Salt (g)	2	2	2	2

WF: wheat flour; SPF: sweet potato flour; B.P: Baking powder.

Table 2: Ingredients of biscuits prepared with WF only and SPF.

		Preparation with using SPF		
Ingredients	Control (100%) wheat flour	10%	20%	30%
Wheat flour (g)	220	198	176	154
Yellow sweet potato flour (g)	0	22	44	66
Sucrose (g)	120	120	120	120
Butter (g)	110	110	110	110
Eggs (g)	45	45	45	45
Milk (ml)	10	10	7.5	5
B.P*	5	5	5	5
Vanillin (g)	5	5	5	5
Salt (g)	2	2	2	2

WF: wheat flour; SPF: sweet potato flour; B.P: Baking powder.

Table 3: Physical properties of cupcakes prepared with different levels of SPF

		Cupcakes prepared with different levels of SPF		
Physical properties	Control 100 WF	10%	20%	30%
Weight (g):				
Before baking	56	56	56	56
After baking	50.25	49.00	47.50	47.00
Change in weight (%)	89.73	87.50	84.82	83.93
Relative to control (%)	100	97.51	94.53	93.54
Height (cm)	3.80	3.80	3.70	3.63
Relative to control (%)	100	100	97.37	95.53
Volume (cm^3)	82	80	80	79.50
Relative to control (%)	100	97.56	97.56	96.95
Density (g/cm^3)	0.61	0.61	0.59	0.59
Relative to control (%)	100	100	96.72	96.72

Table 4: Organoleptic properties of cupcakes prepared with different levels of SPF

	Parameters as Mean±SD			
		Cupcakes prepared with different levels of SPF		
Characteristics	Control 100 WF	10%	20%	30%
Appearance	9.05±0.83	9.10±0.85	9.05±0.99	8.85±1.02
Exterior color	7.60±1.10^{b}	8.25±1.30^{ab}	8.85±1.14^{a}	7.60±1.23^{b}
Interior color	9.30±0.73^{a}	7.75±1.07^{b}	7.55±1.32^{b}	7.25±1.02^{b}
Taste	7.60±1.35	7.60±1.31	8.45±1.61	7.75±1.12
Sweetness	7.25±1.80^{b}	8.25±1.21^{a}	8.65±1.46^{a}	8.40±0.99^{a}
Odor	7.70±1.45^{b}	8.20±1.20^{b}	9.30±1.30^{a}	7.85±1.66^{b}
Cell uniformity	8.05±1.19^{a}	7.95±1.50^{a}	7.60±1.50^{a}	6.55±1.54^{b}
Tenderness	8.30±1.56	7.85±1.42	7.60±1.54	7.45±1.05
General acceptance	7.90±1.80^{ab}	8.10±1.52^{a}	8.75±1.25^{a}	6.95±1.96^{b}

Different superscript letters in the same row denotes significant differences at $P<0.05$

SD: Standard division

Table 5: Proximal composition of cupcakes prepared with different levels of SPF

	Parameters per 100g of dry weight of			
		Cupcakes prepared with different levels of SPF		
Composition	Control 100 WF	10%	20%	30%
Moisture (g)	10.00	9.94	9.91	9.89
Ash (g)	1.00	1.20	1.31	1.39
Total protein (g)	10.23	10.12	9.69	9.45
Total fat (g)	17.21	17.15	17.11	16.98
Total carbohydrate (g)*	61.56	61.59	61.98	62.29

* By difference

Table 6: Physical properties of biscuits prepared with different levels of SPF

		Biscuits prepared with different levels of SPF		
Properties	Control	10%	20%	30%
Weight (g):				
Before baking	13	13	13	13
After baking	12	12	11.75	11.50
Change in weight (%)	92.31	92.31	90.38	88.64
Relative to control (%)	100	100	97.91	95.83
Thickness (cm)	0.84	0.83	0.82	0.82
Relative to control (%)	100	98.81	97.62	97.62
Volume (cm^3)	23.60	23.60	23.50	23.30
Relative to control (%)	100	100	99.58	98.73
Density (g/ cm^3)	0.51	0.51	0.50	0.49
Relative to control (%)	100	100	98.04	96.07

Table 7: Organoleptic evaluation of biscuits prepared with different levels of SPF

	Parameters as Mean±SD			
		Biscuits prepared with different levels SPF		
Characteristics	Control	10%	20%	30%
Appearance	8.25±1.12	8.25±1.12	8.55±1.57	7.95±1.05
Exterior color	7.55±2.01	7.95±0.83	8.10±1.33	8.15±1.04
Interior color	9.30±0.73[a]	7.53±2.32[b]	6.95±2.04[b]	6.45±2.37[b]
Taste	8.01±0.79	8.07±0.73	8.05±1.57	8.25±1.07
Sweetness	8.35±1.09	8.65±1.23	8.75±0.79	8.80±0.77
Odor	7.80±1.47[b]	8.60±0.94[a]	8.65±0.75[a]	8.35±1.23[ab]
Crispy	7.25±1.37[b]	7.65±1.27[ab]	8.15±1.79[ab]	8.25±1.21[a]
General acceptance	8.10±1.52	8.20±1.01	8.65±0.93	8.75±1.25

Different superscript letters in the same row denotes significant differences at P<0.05
SD: Standard division

Table 8: Proximal composition of biscuits prepared with different levels of SPF

	Parameters per 100g of dry weight			
		Biscuits prepared with different levels of SPF		
Proximal composition	Control	10%	20%	30%
Moisture (g)	3.70	3.50	3.32	3.13
Ash (g)	1.15	1.22	1.29	1.32
Total protein (g)	11.68	11.65	11.61	11.53
Total fat (g)	20.91	20.90	20.88	20.87
Total carbohydrate (g) *	62.56	62.73	62.90	63.15

* By difference

appearance, exterior color, taste, sweetness and general acceptability for baked biscuits with the three different levels of SPF were not significant changed at p<0.05 as compared to that of control (100% WF). The highest scores of appearance, exterior color and general acceptability were found in prepared biscuits with 20% of SPF as compared to that prepared with 100%WF (control) and with the other levels of SPF. However, sweetness score of prepared biscuits with using 30% SPF was the highest as compared to that of control and that prepared with 10 and 20% SPF. Means±SD scores of interior color were significantly reduced in baked biscuits with the three different levels of SPF compared to that of control. Scores of odor for baked biscuits with 10 and 20 % of SPF as replacement of WF were significantly increased compared to that of baked biscuits with 100% WF. Baked biscuits with 30% SPF as replacement of WF had significantly increased of crispy compared to that of control.

Major Proximate Composition: Data of chemical composition for biscuits prepared without and with the different levels of SPF as replacement of WF are recorded in Table 8. It showed that prepared biscuits with the different levels of SPF had the lowest values of moisture, total protein and total fat as compared to that prepared with 100% WF. Values of ash and total carbohydrate content was higher in baked biscuits with the different levels of SPF as compared to that prepared with 100% WF.

DISCUSSION

The present study was done to investigate the effect of yellow sweet potato flour (SPF) as replacement of wheat flour (WF) on cupcakes and biscuits properties. Regarding physical properties examination of cupcakes, our study revealed lowest weight and volume values after baking of baked cupcakes with different levels of SPF compared to that prepared with 100% WF. On the other hand, baked biscuits using levels of 20 and 30% SPF had slight decreases in the values of weight (g), volume (cm^3) density (g/cm^3) and thickness (cm) compared to control. These results were in conformity with Srivastava *et al.* [18] who reported that there is a slight decrease in the thickness, spread ratio, volume and density of biscuits after incorporating different concentrations of SPF and

this is due to the higher water holding capacity of SPF. The volume of sweet potato biscuit decreased linearly whereas, density increased in the similar manner. This may be due to higher fiber content in the flour. In agreement with our study, Singh *et al.* [19] who stated that there was significant decrease in thickness of cookies with marginal increases in sweet potato flours. According to Khaliduzzaman and Islam [20] who reported that thickness of biscuit increased slightly with increasing level of potato flour replacement up to 25%. On the other hand diameter of biscuits and spread ratio are decreased as substitution level of potato flour increased in the baked samples.

Results of organoleptic evaluation indicated that the differences in scores for cupcakes prepared with the different levels of SPF were not significant changes. But higher score of sweetness showed in cupcakes prepared with 30% SPF. Odor of prepared cupcakes with 20% of SPF significantly change compared with that prepared with 10 and 30% and control. Baked cupcakes with 30% SPF had significant lower scores of cell uniformity. Regarding the general acceptability of cupcakes prepared with different levels of sweet potato flour, higher acceptable score was found for prepared cupcakes with 20% SPF which was significantly increased.

Regarding to sensory evaluation for baked biscuits the present data revealed that score values of appearance, exterior color, taste, sweetness and general acceptability for baked biscuits with the three different levels SPF were not significant changes. These results agreed with Srivastava *et al.* [18] who indicated that the percent score of biscuits containing 40% SPF were found to be the most acceptable. At 40% level of incorporation, all the attributes scored highest level. The color scores of biscuits with 40% SPF reached maximum than to the rest of the proportions similar to the control sample. Thus, incorporation of SPF at 40% level improved the sensory attributes namely texture, flavor, color and over all acceptability. The sensory evaluation depicts that highest amount of sweet potato flour that can be incorporated to develop acceptable biscuit was 40%, which was the best regarding all sensory attributes. Recently, Olapade and Ogunade [21] indicated that acceptable crunchy snacks can be prepared from sweet potatoes flour and are suitable for making snacks without much significant change in the organoleptic characteristics of the product. The change in color may be due to increasing level of SPF which gave a dark brown color to biscuit which was not liked much by the panelist. Similarly, the score of taste, flavor and texture also reduced significantly. This was because of typical flavor component and caramelization of free sugar in sweet potato flour during baking [22].

Regarding major proximate composition, the obtained results demonstrated that baked cupcakes with the different levels of SPF had the lowest values of moisture, total protein and total fat compared to that prepared with 100% WF. In contrast, higher values of ash and total carbohydrate content was found in baked cupcakes with the different levels of SPF compared to that prepared with 100% wheat flour. In contrast, other studies stated that sweet potato is comparatively a nutritional heavy weight; rich in complex carbohydrates, vitamins C and E and also contains good quantities of vitamins A and B, calcium and iron [23]. Recently, Srivastava *et al.* [18] showed the peculiar characteristics (moisture, protein, ash, fiber and fat) of sweet potato flour. Therefore, the obtained results could be very valuable in decision making for industries that want to take nutritional advantage of sweet potato flour as alternative or supplement to cereal flours.

CONCLUSION

Sweet potato can and does, play a multitude of varied roles in the human diets being either supplemental or a luxury food besides being a staple crop for some parts of the world. Sweet potato flour can commercially use in the bakery products as a replacement of wheat flour at levels of 20% for cakes and 30% for biscuits economically production and improve product properties

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