EFFECT OF USING SWEET POTATO AND POTATO FLOURS ON PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF SPONGE CAKE

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ABSTRACT

Sponge cake was prepared by replacement sweet potato and potato flours (refused small size) at levels 10, 20 and 40%. Chemical composition of sweet potato and potato flours showed that sweet potato had lower moisture and fiber contents. ß- carotene content, increased from 12 to 30 and 40 mg/100g when sweet potato was incorporated from 0 to 40 % into the sponge cake formulation. Farinograph readings indicated that water absorption increased significantly from 58.2 % to 65 % with increase sweet potato flour to 40 %. Resistance to extension values are increased with increasing the sweet potato to 10 % and decreased at the other levels. Regarding physical characteristics of sponge cake, results revealed that sweet potato flour at levels 10 % and 20 % caused increase in sponge cake volume. Also, the specific volume of sponge cake increased with each increase of substitution. On the other hand, it was noticed that, organoleptic scores of sponge cake supplemented with sweet potato at level 20 % and potato flour at 10 % increased, otherwise there was no significant differences between control and supplemented sponge cake. The results showed also that sweet potato and potato flours had antimicrobial effect .In general, the overall acceptability of sponge cakes was improved by 20 % sweet potato and 10 % potato flours substitution.

Key words: sweet potato, potato flour, ß- carotene, total phenol, sponge cake batter, organoleptic evaluation.

INTRODUCTION

In most developing countries, wheat production is limited and wheat must be imported to meat local demand. Sweet potato *(Ipomoea batatas)* and potato (*Solanum tuberosum L.*) which belongs to the family Convolvulaceae are naturally gluten- free has been widely cultivated for centuries in various geographic regions. The prevalence of celiac disease, an intolerance of gluten, has been reported to be as high as one in 200 of the world population **(Fasano & Catassi, 2001).** The majority of those diagnosed with this disease are silent and latent cases, which have the potential but may or may not develop the disease **(Feighery, 1999)**. Sweet potato has been used as food and herb in many countries (**Yin *et al.*, 2008).** Sweet potato and potato can be processed into flour and can partly substitute for wheat and other cereals flours, and enrich ß - carotene content in bakery products. It is an economical and healthful food crop that has been widely grown in many parts of the world. Sweet potato, in which vitamin C, chlorogenic acid, caffic acid, quercetin and rutin are abundant, is one of the functional food products aimed at introducing human dietary ingredients that aid specific body functions in addition to being nutritionous **(Guan *et al.*,**

2006). It is the world's seventh most important food crop after wheat, rice, maize, potato, barley and cassava (**Woolke, 1990, Ray & Ravi, 2005**). The sweet potato tubers are rich in starch, sugars, vitamin C, provitamin A, iron and minerals (**Woolfe, 1992 and Ray & Ward, 2006).** The colored varieties contain pigments: ß-carotene, anthocyanin and unidentified flavonoids **(Yamakawa, 1998**). These pigments are regarded as antioxidants having several physiological attributes such as antioxidation, anticancer, anti-immunodilation and protection against cataract, ageing, macular degeneration, liver injury **(Mayne, 1996, Bohm *et al.*, 1997 and Yamakwa, 1998).** Night blindness is a major physiological disorder among rural and tribal people in many developing and undeveloped countries **(Woolfe, 1992 and Kays & Kays, 1998)** because of vitamin A deficiency, at the same time, more and more modern research has shown that sweet potato has antimicrobial, antihypertensive activities and has ultraviolet protection effects (**Jansson & Raman, 1991, Woolfe, 1992, Zhan, 1996, Yoshimoto *et al.*, 1999, Yoshimoto, 2001, Yoshimoto *et al.*, 2001, Oki *et al.*, 2002, Matsui *et al.*, 2002, Cevallos-Casals, 2003 and Cambie & Ferguson, 2003).**

Sponge cake is one of the most important energy foods in human diet. The specific objectives of this study were, to formulate cakes supplemented with vary levels of sweet potato and potato flours and evaluate proximate composition, ß-carotene ,vitamin C, cake volume and moisture loss during 10 day storage period and to characterize the sensory properties of the cake .

MATERIALS AND METHODS

Materials

Refused (small size) sweet potato tubers with deep orange flesh, potato tubers and wheat flour (72 %) were purchased from local supermarket in Fayoum, Egypt. Sweet potato tubers and potato tubers were washed and converted into flour using the following procedure:

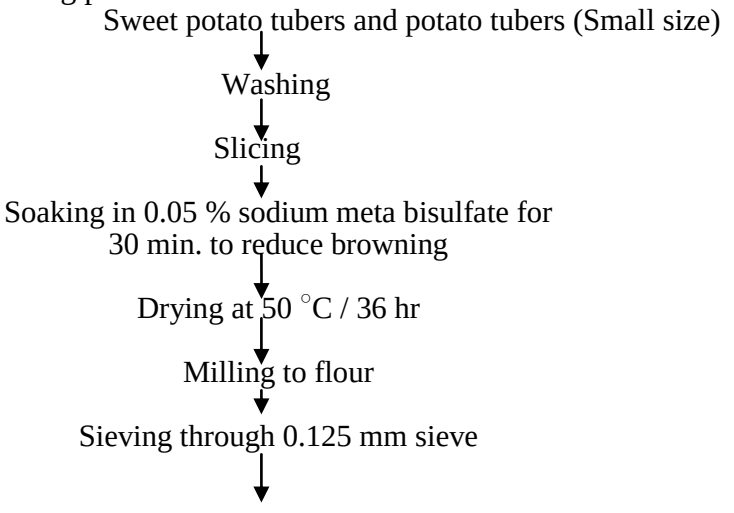

Fig. (1) Flow chart for production of sweet –potato and potato flours

Preparation of sponge cakes

Sponge cakes were prepared according to **(Celic *et al.*, 2007)** with slight modification as follows:

The recipe in Table (1) was used; wheat flour was replaced with sweet potato and potato flours at levels of 10%, 20% and 40%. Egg and sugars were whipped to a cream for 4 min. Then, flour and baking powder were added into the mixture, and it was whipped at medium speed for two minutes. Finally, equal amount of batter (130 g) were poured into pans (8.5 cm length, 5.3 cm width and 9.3 cm height) and baked at 180 °C for 25 min., sponge cakes were allowed to cool at room temperature. They were carefully taken out of the pans and placed in polyethylene bags and stored in dry and cool environment prior to analysis.

Table 1: Sponge cake formula

Ingredient	%
Flour (72 %)	33.00
Egg	31.00
Sugar	32.00
Baking powder	3.00
Vanillin	0.50
Salt	0.50

Analytical methods

Sweet potato flour, potato flour, wheat Flour (72%) and sponge cake were analyzed for moisture, protein, ash, crude fiber, ether extract contents, ascorbic acid and ß- carotene, according to **AOAC, (2000)**. Reducing and non reducing sugar were determined according to **Lane & Eynon (AOAC, 2000)** method. Nitrogen free extract was calculated by difference.

Total phenol content

Raw materials (wheat flour 72 % ext., sweet potato, potato flours) and sponge cakes prepared from 0 %, 10 %, 20 % and 40 % sweet potato and potato flours were analyzed for total phenol content. One g of defatted sample (after refluxing with chloroform and petroleum ether, (1:1 v/v) followed by drying) was mixed with 10 ml of water for aqueous extraction (WE). Similarly for methanol extraction (ME), stirred and centrifuged at 2000 r.p.m.for 15 min. The above supernatants were referred as water extract (WE) and methanol extract (ME), respectively. The total phenolic contents of the WE and ME were determined colorimetrically using the Folin- Cicolteau method (**Singleton *et al.*, 1999).** The absorbance was measured at 765 nm. The total phenolic content was expressed as milligram tannic acid equivalent (TAE) per gram sample.

Dry gluten

Dry gluten was determined in the wheat flour blends (were prepared by replacement sweet potato and potato flours at levels 10, 20 and 40%) according to the method given in **A.A.C.C., (2000).**

Rheological properties

The effect of sweet potato and potato flours substitution on the mixing and the elastic properties profile of the dough were studied using farinograph and extensograph according to the standard **A.A.C.C., (2000).** Specific gravity of cake batters was determined by the method of **Lee and Hoseney (1982).** pH values of cake batters were monitored with a pH meter.

Physical measurements of sponge cake

After the sponge cake was cooled to room temperature, it was taken out of the cake pan and weighed to calculate the baking loss as follows:

Baking loss (%) = (1- (cake weight / batter weight)) x 100

Volume (V, Cm^3) of sponge cake was measured using clover seed displacement method. Weight of the cakes was measured (W, g) and density was calculated by ratio of cake volume to cake weight.

Storage studies

Sponge cakes samples packaged in polyethylene bags and sealed were marked for 0, 2,4,6,8 and10 days of storage at room temperature (35 $\pm 2^{\circ}C$). These samples were analyzed daily for moisture.

Microbiological examination

Total plate count (TPC) and the total mold and yeast medium were used for detecting the microbial count according to the methods described by **Julseth & Deible (1974)**

Organoleptic evaluation

The organoleptic evaluation of cakes was carried out, using a panel taste according to **Mostafa, (1976).** The panelists were asked to evaluate the cakes for shape, crust color, crust appearance, crumb color, texture, grain cell structure, odor and taste.

Statistical analysis

Analysis of variance was computed using the general linear model (GLM) procedure of statistical analysis system **(SPSS, 1999).** Differences among means were evaluated using Duncan's multiple range test **(Duncan, 1955).**

RESULTS AND DISCUSSION

Chemical composition

The mean values of proximate composition (moisture, ether extract, protein, crude fiber, ash and nitrogen free extract) of sweet potato flour, potato flour and wheat flour (72%) samples are presented in Table (2). Data show the wheat flour had high amount of moisture (13.64 %) followed by potato flour (5.17%) and sweet potato flour (4.14%). As concerning protein content it is observed that wheat flour had high percentage of protein (11.36 %) followed by sweet potato flour (6.86%) and potato flour (1.99%). Most cereal flour contains, except wheat flour, less than 9 % protein. These results are in agreement with the range of these components reported by **Tian *et al.*, (1991).** Reducing, non reducing and total sugars content are given in Table (3). Reducing sugars contents in sponge cake were increased in supplemented sponge cake with sweet potato or potato flour compared to control. The increasement was observed

proportionally with the increase in level of substitution. As the sweet potato and potato tuber were not peeled before drying; the flour had a relatively high level of crud fiber. The largest analytical component in sweet potato and potato flour was the NFE, which, it can be supposed, was mainly starch in tuber. These results are in agreement with **(Afookwa & Sefa- Dedeh, 2001and Hsu *et al.*, 2004).**

Table (2): Chemical composition of wheat, sweet potato and potato flours*

Parameter %	Wheat flour (72%)	Sweet potato flour	Potato flour
Moisture	13.64 ± 0.65^{a}	4.14 ± 0.06^{b}	5.17 ± 0.05^{b}
Protein	11.36 ± 0.48^{a}	6.86 ± 0.26^{c}	1.99 ± 0.04^{c}
Ether extract	2.01 ± 0.08^{b}	3.96 ± 0.08^{b}	0.22 ± 0.08^{a}
Ash	0.71 ± 0.05^{c}	1.80 ± 0.10^{a}	1.09 ± 0.10^{a}
Crude fiber	0.92 ± 0.08^{c}	0.38 ± 0.08^{ab}	0.59 ± 0.08^{a}
N.F.E.**	85.00 ± 0.12^{b}	87.00 ± 0.42^{b}	96.11 ± 0.12^{a}

*On dry weight, ** N.F.E.: nitrogen free extract , Mean value for three samples, ± Standard deviation ,Means in the same row with different letters are significantly difference at $P\leq0.05$.

Polyphenolics from various plant sources are receiving increasing attention due to the desirable physiological functions associated with antioxidant activities **(Ishiguro *et al.*, 2007**). They prevent oxidative stress that increases risk for many diseases **(Hagerman *et al.*, 1998, and Kaul & Khanduja, 1998).**Total phenol content for tested samples is illustrated in Table (3) .The data shows that the sweet potato flour had higher contents of total phenol (13.92 mg/g).

The ß – carotene and ascorbic acid contents of wheat flour, sweet potato flour, potato flour and sponge cake are presented in Table (4). With the increase in sweet potato flour in sponge cake, the concentration of ß –carotene in sponge cake increased proportionally. ß – Carotene pigments are considered to be a rich source of antioxidant substances **(Yamakaw, 1998).** Sweet potatoes are rich in carotenoids, especially ß –carotene, which is basically absent in whole wheat flours and bakery products **(Van Hal, 2000**).

Ascorbic acid content was found to be 96.67 mg/100g for sweet potato and was found to be 82.95 mg/100 g in potato flour; this slight difference could be due to the maturity stage according to **(Mazza, 1984)** who reported that such vitamin content increased with growth and maturity of potato tubers. The lowering of ascorbic acid for sponge cake than flours was propabably because of the thermal degradation during baking of sponge cake.

Table (3): Total sugars and total phenol contents of sweet potato flour, potato flour and sponge cake*

Sample	Reducing sugar %	Non-reducing sugars %	Total sugars %	Phenols (mg/g)		
				Water extract (mg/g)	Methanol extract (mg /g)	Total phenol (mg/g)
Wheat flour 72% (WF)	0.96 ±0.14^{a}	0.44±0.23^{c}	4.50±0.14^{b}	0.78±0.32^{c}	0.41±0.09^{a}	1.19±0.12^{g}
Sweet potato flour (SPF)	1.89±0.08^{b}	2.61±0.12^{b}	2.91±0.06^{c}	5.51±0.30^{a}	8.41±0.16^{c}	13.92±0.10^{a}
Potato flour (PF)	0.99±0.25^{a}	28.61±0.22^{a}	31.50±0.12^{a}	1.31±0.12^{b}	5.51±0.11^{b}	6.82±0.01^{c}
Sponge cake						
-control(WF)	2.89±0.19^{ab}	28.72±0.08^{a}	31.61±0.09^{a}	4.50±0.09^{b}	0.76±0.01^{b}	5.26±0.21^{e}
-with 10 % SPF	5.65± 0.12^{c}	26.36±0.19^{a}	32.01±0.12^{a}	5.61±0.24^{a}	2.30±0.20^{a}	7.91±0.31^{c}
-with 20 % SPF	7.22± 0.90^{c}	24.48±0.09^{b}	31.70±0.17^{a}	5.75±0.08^{a}	3.01±0.15^{a}	8.76±0.06^{b}
-with 40 % SPF	8.19 ±0.08^{d}	23.96±0.31^{b}	32.15±0.19^{b}	3.89±0.19^{c}	3.12±0.09^{a}	7.01±0.12^{c}
-with 10 % PF	4.50 ±0.05^{c}	27.57±0.33^{a}	32.07±0.01^{b}	3.62±0.12^{c}	1.29±0.012^{b}	5.91±0.09^{d}
-with 20 % PF	5.01 ±0.11^{c}	27.07±0.15^{a}	32.08±0.01^{b}	3.01±0.09^{c}	1.81±0.19^{b}	4.82±0.01^{f}
-with 40 % PF	6.44 ±0.13^{cb}	26.63±0.48^{b}	33.07±0.32^{ab}	3.51±0.18c	1.89±0.09^{b}	5.40±0.10^{d}

Mean value for three samples, ± Standard deviation, Means in the same column with different letters are significantly difference at P≤0.05.

Table (4): ß–Carotene and ascorbic acid contents of wheat flour, sweet potato flour, potato flour and sponge cake*

Sample	ß – Carotene (mg/100 g)	Ascorbic acid (mg/100 g)
Wheat flour 72 %(WF)	12±1.00^{C}	40.66 ± 3.05^{C}
Sweet potato flour (SPF)	32 ±2.52^{A}	96.67± 2.08^{A}
Potato flour (PF)	18 ± 1.53^{B}	82.95± 3.78^{B}
Sponge cake		
- control	20 ±1.00^{a}	45±0.81^{c}
-with 10 % SPF	30±2.40^{b}	60±2.02^{d}
- with 20 % SPF	35±0.47^{b}	80±.21^{cb}
- with 40 % SPF	40±0.21^{c}	43±0.33^{c}
- with 10 % PF	23 ±0.09^{c}	50±0.45^{c}
- with 20 % PF	25±0.31^{c}	55±0.09^{c}
- with 40 % PF	30±0.04^{b}	68±0.09^{b}

Mean value for three samples, ± Standard deviation, Means in the same column with different letters are significantly difference at P≤0.05.

Gluten content

The effect of sweet potato and potato flour on the gluten content is shown in Table (5). With the increase in sweet potato and potato flours in sponge cake, the gluten content decreased proportionally. For there this sponge cake can use for decrease the celiac disease **(Shih *et al.*, 2006)**.

Table (5): Effect of sweet potato and potato flours on gluten content*

Sample	Gluten content (%)
-Wheat flour72 %(W.F)	11.11 ± 0.096^{a}
- W.F with 10 % SPF	$10.44\pm.427^{ab}$
- W.F with 20 % SPF	10.54 ± 0.215^{a}
- W.F with 40 % SPF	$9.06^{\pm}0.049^{cd}$
- W.F with 10 % PF	$9.70\pm.098^{bc}$
- W.F with 20 % PF	9.75 ± 0.91^{bc}
- W.F with 40 % PF	8.81 ± 0.86^{d}

Mean value for three samples, ± Standard deviation, Means with different letters are significantly difference at P≤ 0.05.

Rheological characteristics

The results of the dough properties as affected by sweet potato and potato flours are shown in Table (6). Increase in sweet potato and potato flours content in the blend from 0 to 10% increased the water absorption from 58.22% to 63% and 60.5% for sweet potato and potato flours, respectively. Dough development time decreased from 2.5 to 2.00.

The dough stability as an indicator to dough strength decreased in all treatments in comparison to the control (WF). That means that the dough becomes weak due to replacement with either SPF or PF. The effect of sweet potato and potato flours on the elastic properties of the dough are illustrated in Table (7). With the use of sweet potato 10 %, the resistance to extension values increased from 700 to 720 BU and extensibility values increased from 120 mm to 137 mm. But more substitution caused less resistance to extension and also low energy. On the other hand, when the sweet potato and potato flour was increased the proportional No. was decreased. This may be either due to the dilution of gluten proteins or interactions between polysaccharides and proteins from wheat flour as reported by **Chen *et al.*, (1988).**

Table (6): Farinograph readings of wheat flour (72 % ext.) as affected by supplemented with sweet potato and potato flours

	Water absorption (%)	Arrival time (min.)	Dough development time (min.)	Dough stability (min.)	Dough weakening B.U
Wheat flour 72 %(WF)	58.20	1.50	2.50	3.50	30
W.F+ Sweet potato flour					
10%	63.00	1.50	2.00	1.50	30
20%	64.30	1.50	2.00	2.00	80
40%	65.00	1.50	1.50	2.00	80
W.F +potato flour					
10%	60.50	1.50	2.00	2.00	30
20%	61.56	1.50	2.00	1.50	40
40%	62.10	1.50	2.00	1.50	70

Table (7): Effect of sweet potato and potato flours on Extensograph parameter

Samples	Extensibility (E, mm)	Resistance of Extension (R, BU)	Proportional number (R/E)	Energy (cm2)
Wheat flour72 % (WF)	120	700	5.83	133.30
W.F+ Sweet potato flour				
10%	137	720	5.25	143.80
20%	130	500	3.83	99.70
40%	160	530	3.31	100.50
W.F + Potato flour				
10%	145	500	3.45	159.00
20%	150	480	3.20	146.00
40%	150	420	2.80	111.50

Physical properties of cake batter

Analytical measurements results of sponge cake batter are given in Table (8). Data show the specific gravity was decrease by using sweet potato flour at all level of supplementation. In contrary point this property was increased by using potato flour as additives at all level. Density (specific gravity) is usually determined by the ratio of cake batter weight to the weight of distilled water at the same temperature. Specific gravity indicates the ability of proteins to incorporated air into the batter, and it is related to air cell size distribution in baked cakes **(Arunepanlop *et al.*, 1996).** Differences among the pH values of cake batters with different levels of substitution were significant at high level of supplementation (20% or 40%) by using either sweet potato or potato flours.

Table (8): Effect of sweet potato and potato flours on the physical properties of sponge cake batter

Sponge cake batter	pH	Specific gravity (g/cm3)
Control (W.F 72%)	7.12 ± 0.10^{c}	0.78 ± 0.02^{c}
W.F+ Sweet potato flour		
10%	7.21 ± 0.05^{ab}	0.73 ± 0.01^{d}
20%	$7.23\pm.03^{ab}$	0.74 ± 0.01^{d}
40%	$7.26\pm.01^{a}$	0.74 ± 0.01^{d}
W.F + Potato flour		
10%	7.17 ± 0.01^{bc}	0.85 ± 0.04^{b}
20%	7.22 ± 0.05^{ab}	0.87 ± 0.02^{ab}
40%	7.25 ± 0.01^{ab}	0.88 ± 0.07^{a}

Mean value for three samples, ± Standard deviation, Means in the same column with different letters are significantly difference at $P\leq0.05$.

Cake volume is used as a criterion to measure the quality of fresh cake in research, quality control in industry and by consumers. As shown in Table (9). The volumes of sweet potato cake ranged from 316 to 467 Cm^{3} insignificant decreasing as level of sweet potato increased. On the other hand there is a significant decreasing as the level of potato flour increase. Some weight loss is

inevitable when cake (generally bakery products) is baked because of moisture loss during the baking process. There were slight differences in weight loss among the tested cake samples.

Table (9): Effect of sweet potato and potato flours on physical properties of sponge cake*

Treatments	Cake volume (Cm 3)	Cake weight (g)	Specific volume (Cm 3 /g)	Sponge cake height (cm)	Baking loss %
Control (W.F72%)	463±2.88^{ab}	123.66±3.21^{bc}	3.74±0.19^{e}	5.50±0.21^{a}	4.77±0.20^{b}
Sweet potato flour					
10%	467±9.84^{a}	121.66±2.88^{c}	3.84±0.25^{cd}	7.50±0.09^{c}	6.41±0.01^{a}
20%	446±2.88^{b}	127.00±1.00^{ab}	3.51±0.03^{d}	7.00±0.08^{c}	2.30±0.32^{d}
40%	455±5.00^{ab}	124.5±1.32^{ab}	3.65±0.52^{bc}	6.90±0.11^{c}	4.23±0.42^{b}
Potato flour					
10%	383±10.40^{c}	125.50±2.29^{abc}	3.05±0.06^{b}	6.20±0.19^{b}	3.46±0.08^{c}
20%	371±16.44^{c}	126.73±1.50^{ab}	2.93±0.17^{b}	6.00±0.20^{b}	2.51±0.09^{d}
40%	316±15.27^{d}	128.16±1.04^{a}	2.46±0.15^{c}	5.90±0.14^{a}	1.41±0.01^{e}

Mean value for three samples, ± Standard deviation, Means in the same column with different letters are significantly difference at$P\leq0.05$**.**

Proximate composition of sponge cake

The proximate composition of the sponge cake supplemented with sweet potato and potato flours is shown in Table (9), where it could be noticed that the chemical composition of sponge cake was affected by the addition of sweet potato and potato flours. Ash, crude fiber and N.F.E. were increased in sponge cake.

Table (10): Chemical composition of sponge cake with sweet potato and potato flours*

Treatments	Moisture %	Protein %	Ether extract%	Ash %	Crude fiber %	N.F.E.* %
Control (W.F) 72%	26.23±0.25^{f}	13.7±0.26^{a}	1.05±0.04^{ab}	0.52±0.03^{c}	0.56±0.01^{c}	83.65±0.01^{d}
Sweet potato flour						
10%	27.10±0.18^{d}	10.03±0.06^{bc}	1.03±0.05^{b}	0.57±0.09^{ab}	0.6±0.09^{b}	86.32±0.12^{b}
20%	28.16±0.25^{b}	10.63±0.23^{b}	1.13±0.05^{a}	0.66±0.23^{ab}	0.69±0.18^{a}	85.49±0.20^{c}
40%	30.10±0.01^{a}	9.60±0.73^{c}	0.90±0.01^{c}	0.71±0.09^{a}	0.72±0.13^{a}	86.63±0.15^{b}
Potato flour						
10%	26.47±0.45^{ef}	9.54±0.38^{c}	0.86±0.06^{c}	0.63±0.12^{ab}	0.59±0.23^{a}	88.03±0.30^{a}
20%	26.80±0.20^{de}	9.81±0.18^{c}	0.86±0.04^{c}	0.68±0.19^{a}	0.61±0.09^{b}	87.59±0.05^{ab}
40%	27.60±0.35^{c}	9.37±0.04^{c}	0.84±0.05^{c}	0.70±0.10^{a}	0.64±0.08^{b}	87.97±0.06^{a}

*On dry weight, ** N.F.E.: nitrogen free extract, Mean value for three samples, ± Standard deviation ,Means in the same column with different letters are significantly difference at P≤ 0.05 .

Organoleptic evaluations of sponge cakes

As a matter of fact, organoleptic properties are the final guide to the quality from the consumer point of view. Therefore, the application of the sweet potato flour and potato flour was carried out on sponge cake to investigate their effect on sensory properties. The sensory results of sponge cake are presented in Table (11). The sensory results of sponge cakes showed that the effect of sweet potato flour on sponge cake was insignificant. Though the overall quality scores reduce, the cakes prepared from 10 % sweet potato was highly acceptable. The flavor of bakery products is a result of the aroma compounds produced by enzymatic, fermentative and thermal reaction of sugar and starch during baking and the aroma compounds deliberately added to the products to obtain baked goods with specific aromatic characteristics. **(Pozo- Bayoyon *et al.*, 2007).**

Table (12): Changes of water content in sponge cakes supplemented with sweet potato and potato flours during storage

Storage period (Day)	Water contents (%) *						
	Control	Sweet potato flour			Potato flour		
		10%	20%	40%	10%	20%	40 %
0	38.11	38.40	38.90	39.70	35.22	35.91	36.50
2	37.30	37.70	38.01	39.1	33.90	34.66	35.01
4	34.12	36.01	37.50	38.2	32.11	31.01	32.06
6	30.21	35.41	36.20	37.30	28.61	29.01	30.11
8	27.11	34.70	35.81	36.55	25.66	25.99	32.22
10	22.01	31.11	34.91	35. 99	23.06	23.19	29.60

* Mean value for three samples.

Effect of storage on water content of sponge cakes

During storage studies, sponge cakes supplemented with sweet potato and potato flour were analyzed for moisture content, and the results are presented in (Table 12). As expected, all samples showed a definite decrease in crumb moisture content during 10 days of storage.

The moisture content was decreased from 38.11% to 22.01%, 38.4% to 31.11% and from 35.22% to 23.06% for control, sponge cake supplemented with10% sweet potato flour and potato flour, respectively. In the course of storage, the moisture migrates from the crumb toward the crust and evaporates from the surface of the product **(Piozza & Masi, 1995).**

Effect of storage the supplemented sponge cake on total microbial count

The total microbial counts of different supplemented cakes under investigation were followed up directly after preparation and during the storage time at room temp. (35 ±2 °C), to assess one of the most important factors in evaluation of sponge cake, i.e., safety and quality. The obtained data are presented in Table (13). From these results, it could be observed that substitution of sweet potato (10 %, 20 % and 40 %) inhibited mold and yeast growth during the first six days of storage at room temp. In contrast, the control sponge cake spoiled after just 2 days. The inhibitory effect of sweet potato and potato flours

was mentioned by **(Moreno *et al.*, 1994, and Huang *et al.*, 2008)**. Concerning total yeast and mold counts, substitution of wheat flour with sweet potato and potato flours (at different levels) gave completely growth inhibition up to 10 days at room temp. (35 ± 2 °C), and then a slight growth of fungi was recorded from the 11 day of storage for cakes with 10 % sweet potato and 20 % potato flours; this may be attributed to starch and the low moisture content in addition to the high content from total phenols.

Table (13): Total bacterial and fungal counts (CFU) of sponge cake substituted with sweet potato and potato flours during storage at room temp. (35 ± 2 °C) for 10 days.

Sponge cake sample	Storage period (days)											
	0		2		4		6		8		10	
	TBC	F&M	TBC	F&M	TBC	F&M	TBC	F&M	TBC	F&M	TBC	F&M
Control(W.F)	0	0	0	0	32	0	60	10	125	20	160	35
Sponge cake with												
-10 % SPF	0	0	0	0	0	0	0	0	15	5	25	8
-20 % SPF	0	0	0	0	0	0	0	0	18	4	30	7
-40 % SPF	0	0	0	0	0	0	0	0	20	4	20	5
-10 %PF	0	0	0	0	0	0	0	0	30	12	40	16
-20 %PF	0	0	0	0	0	0	0	0	38	8	35	17
-40 %PF	0	0	0	0	0	0	0	0	33	9	35	14

TBC: Total bacterial count

F&M: Fungi and mold count

Conclusions

The results showed that the use of sweet potato and potato flours in partial replacement of wheat flour (20%) could significantly affect sponge cake in a desirable way and can reduce the quantity of wheat flour. This offers opportunities to efficiently use sweet potato and potato flours in the manufacture of sponge cake. Sweet potato (with skin) flour has potential for use in cake making as a good source of poly phenols which has antioxidant properties.

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تأثير إستخدام دقيق البطاطا والبطاطس على الخصائص الطبيعيه والكيميائيه والحسيه للكيك الإسفنجى

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تهدف هذه الدراسة إلي دراسة مدى إمكانية إستبدال دقيق القمح بدقيق كلا من البطاطا والبطاطس (الأحجام الصغيرة ذات السعر المنخفض) بنسب ١٠ و ٢٠ و٤٠% في تصنيع الكيك الإسفنجى. أظهرت نتائج التحليل الكيميائي إنخفاض النسبه المئويه للرطوبه فى كل من دقيق البطاطا والبطاطس مقارنة بدقيق القمح.

وجد أيضا أن نسبة الكاروتين فى دقيق البطاطا أعلى من دقيق البطاطس والقمح. لوحظ زيادة البيتا كاروتين من ١٢ ملجم إلى ٤٠ ملجم / ١٠٠ جم فى الكيك الإسفنجى عندما تم إستبدال دقيق القمح بنسبة ٤٠ % دقيق بطاطا. أوضحت قراءات جهاز الفارينوجراف زيادة نسبة إمتصاص الماء من ٥٨.٢ % إلى ٦٥ % نتيجة لزيادة نسبة الإستبدال إلى ٤٠% دقيق بطاطا وكذلك زادت مقاومة العجينه للشد عند إضافة دقيق البطاطا بنسبة ١٠ % بينما إنخفضت عند مستويات الإستبدال الأخرى . بالنظر إلى الخصائص الطبيعيه للكيك السفنجى وجد أن إستبدال دقيق البطاطا بنسبة ١٠ % و ٢٠% أدى إلى زيادة الحجم والحجم النوعى للكيك . من ناحية أخرى لوحظ إرتفاع نتائج التقييم الحسى لكل عينات الكيك الإسفنجى المختبره إلا أن التحليل الإحصائى لم يعط فروقا معنويه بين هذه العينات والعينه الضابطة. أدى استبدال دقيق القمح بكل من دقيق البطاطا والبطاطس إلى تأثير مثبط النمو الأحياء الدقيقه خلال فترة التخزين.

الكلمات الدالة: دقيق البطاطا- دقيق البطاطس– المركبات الفينولية – الكاروتين – التقييم الحسى - الكيك الإسفنجى.