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Quality Attributes of Pumpkin (*Cucurbita moschata*) Pulp Based Sheets Prepared of Different Fruits Mixtures

Mamoun Omer Abdelgadir[1*], Wedyan Mahgob Moahammed Ahmed[2], Soha Abdalmonem Alsiddig[3]
[1, 2, 3] National Food Research Centre (NFRC), P.O. Box 213, Khartoum North, Sudan
Corresponding Author: Mamoun Omer Abdelgadir
E-mail: mamounabdelgader@yahoo.com

Abstract:
The present study aim at production and investigation of the quality attributes of pumpkin pulp based sheets prepared of pumpkin pulp (*Cucurbita moschata*) and some other fruits mixtures. Four formulations were prepared, where fruits mixtures were added as P (80% Pumpkin pulp), P_M (60% Pumpkin pulp+ 20% Mango pulp), P_T (60% Pumpkin pulp + 20% Tamarind syrup) and P_B (60% Pumpkin pulp + 20% Baobab syrup). Addition of fruit mixtures enhanced the quality attributes of produced sheets. The results showed that sample P_B recorded the highest drying ratio (7.00:1). Sample P_M recorded the lowest moisture content (7.75%), while sample P_B recorded the highest ash content (3.25%) and the highest fiber content (3.13%). Significant effect ($P< 0.05$) on sugars content was observed. Sample P achieved the lowest percentage of total, reducing and nonreducing sugars. The results of pH, total soluble solids and titratable acidity showed that prepared sheets differed significantly ($P< 0.05$). Minerals composition revealed that sample P outstripped the other prepared sheets, where it is recorded the highest content of K, Na and Ca while, sample P_M recorded the highest content of phosphorus (0.16%).

***Keywords*:** Quality attributes, Fruits mixtures, Pumpkin based sheets.

1. Introduction:

Pumpkin is a member of the *Cucurbitaceous* family and has received considerable attention in recent years because of the nutritional and health protective values such as anti-tumor, anti-bacterial, anti-hypertensive (Caili *et al*., 2007). It is very important to have knowledge about it is nutritive value in order to encourage the increase in its consumption and usage for nutritional and technological applications. Pumpkins are relatively low in total solids, usually ranging between 7% and 10% (Alibas, 2007). The good performance of the pumpkin-fiber products in relation to water and glucose highlights the possibility of their usage as food ingredients (Escalada *et al*., 2007). Additionally, pumpkin flesh is a delicious and fully appreciated additive in a diversity of products for children and adults. It is unique constituents, rich in antioxidants and vitamins, allow the pumpkin to have an important health-protecting effect. In fact, the higher values of lipophilic substances such as carotenoids, present in pumpkin varieties can significantly contribute in increasing the uptake of pro vitamin A and lutein, one of the carotenoids with special physiological functions (Murkovic *et al*., 2005).

Pumpkin is a seasonal crop, and since fresh pumpkins are very sensitive to microbial spoilage, even at refrigerated conditions, they must be frozen or dried (Doymaz, 2007). The perishable nature of fruits and vegetables and over dependency of human on fewer plant species created extreme pressure on the fresh produce industries to supply bulk of fresh fruits and vegetables to the burgeoning population, hence, drying technology is one of the most suitable solutions which provide cheap and safe technique for preservation of fruits and vegetables, especially at the peak of production period. Accordingly, farmers can get economic benefit from fruits and vegetable production. Various reasons made Sudan has suitable conditions for the success of drying processing, for instance, rise of temperature degrees, especially at summer period, as well as increased production of fruits and vegetables including pumpkin. Although, Sudanese people have known the cultivation of pumpkin for many decades and they planted different cultivars of it in assorted areas, a limit numbers of products based pumpkin, excepting Jam were manufactured. However, with the absence of studies conducted from the blending pumpkin pulp with different fruits mixtures, this research aim at production of dried pumpkin based sheets prepared of pumpkin pulp (*Cucurbita moschata*) and some other fruits mixtures, besides investigation the quality attributes of produced sheets.

2. Materials and Methods:

2.1 Materials:

A registered pumpkin variety fruit (*Cucurbita moschata*) which is planted in the farm of National Food Research Centre (NFRC) (27 KM North Khartoum State, Sudan were used in this study. Mango fruits (*Mngifera indica* L.), Tamarind (*Tamarindus indica* L.), Baobab *(Adansonia digitata* L.) powder, sugar (sucrose), syrup glucose, Gum Arabic (*Acacia senegal*) powder and lemon fruits were obtained from the local market at Khartoum North City, Sudan. The analytical grades of chemicals used in this experiment were obtained from the lab of Food Dehydration Department of (NFRC).

2.1.1 Raw Materials Preparation:

All raw materials were washed in running tap water then distilled water .The pumpkin fruits were peeled and cut into cubes using dicer machine. Pumpkin seeds and peels were weighed. The cubes were blanched at 80 ^{0}C for 20 min, and then the pulp was obtained using pulper machine (REEVES®, Size 100-11F-18.Columbus, Indiana, USA). Mango fruits were peeled manually using stainless steel knives and then water was added for blanching to obtain pulp. The Tamarind and Baobab fruits were weighted washed, dipped in water for 3 and 2 hours, respectively and then extracted. The ºBrix of the Mango pulp, Baobab and Tamarind syrup were measured by hand refractometer (0-50).

2.1.2 Mixtures Formulation:

Four recipes of the mixtures including the control were formulated in constant amounts of lemon juice (LJ), sugar (S), Gum Arabic powder (GAP) and syrup glucose (SG) as follows:

P = 80% Pumpkin pulp (Control) + 20% (LJ), (S), (GAP), (SG)

$\mathbf{P_M}$ = 60% Pumpkin pulp + 20% Mango pulp + 20% (LJ), (S), (GAP), (SG)

$\mathbf{P_T}$ = 60% Pumpkin pulp + 20% Tamarind syrup + 20% (LJ), (S), (GAP), (SG)

$\mathbf{P_B}$ = 60% Pumpkin pulp + 20% Baobab syrup + 20% (LJ), (S), (GAP), (SG)

2.1.3 Drying Technique:

All blends were spread in thin layers on stainless steal dehydration trays (46 cm wide, 70 cm long and about 5 cm deep).The dehydration trays were held on stands made of metal (about 82 cm high) under moving fans for 3 days at room temperature. Manufactured sheets were rolled and packed in polyethylene pouches for analysis.

2.2 Analytical Methods:

Physicochemical analyses were carried out for the following parameters: moisture content, protein, ash, crude fiber, total soluble solids (TSS) and pH according to AOAC (2008) methods. Titeratable acidity was analyzed according to the method described by Rangana (1979). Total sugars, reducing sugars and non reducing sugars were carried out according to lane and Eynon method as AOAC (1984) . Minerals were determined according to methods of AOAC (1990). Drying ratio was calculated by taking the weight of sample before drying and the weight of sample after drying according to Singh (2007). All proximate analysis was performed in triplicate.

2.2.1 Statistical Analysis:

The experiment was designed using completely randomized design. Data generated was subjected to Statistical Package for Social Science (SPSS) software version 16.0. Means were separated using Duncan's Multiple Range Test (DMRT) according to Mead and Gurnow (1981). The Least Significant Deference (LSD) at 5% level of significance was used.

3. Results and Discussion:

3.1 Drying Ratio:

Table 1 shows the drying ratio of produced samples. The sample containing 60% pumpkin+20% baobab syrup (Sample P_B) recorded the highest drying ratio (7.00:1) while, samples P_T, P_M and P recorded (6.20:1, 6.60:1 and 6.80:1) , respectively. The increase of drying ratio may be attributed to the addition of fruits which is possessed more dietary fibers, total soluble solids and total soluble sugars since dietary fiber had hydrophilic properties and caused increasing in hydration coefficient as stated by (El-Hadidi, 2006). From the economical point of view, drying ratio is considered as crucial factor in drying operation of fruits and vegetables.

Table 1: Drying ratio of pumpkin pulp based sheets prepared of different fruits mixtures

Sheet Sample Mixtures	Drying Ratios
P	6.80 : 1
P_M	6.60 : 1
P_T	6.20 : 1
P_B	7.00 : 1

Where:

P = 80% Pumpkin pulp (Control) + 20% (LJ), (S), (GAP), (SG)

P_M = 60% Pumpkin pulp + 20% Mango pulp + 20% (LJ), (S), (GAP), (SG)

P_T = 60% Pumpkin pulp + 20% Tamarind syrup + 20% (LJ), (S), (GAP), (SG)

P_B = 60% Pumpkin pulp + 20% Baobab syrup + 20% (LJ), (S), (GAP), (SG)

3.2 Moisture Content:

Table 2 show the results for the physico-chemical characteristics of dried pumpkin sheets prepared of different fruits mixtures .Clearly, there were significant difference ($P< 0.05$) in moisture content between sample P (10.75%) and P_M (7.75%), while there was no significant difference between sample P_T (9.75%) and P_B (10%) . Control sample (80% pumpkin) revealed high percentage of moisture content (10.75%) compared with other treated samples. This could be due to the ingress of moisture from the atmosphere through the packaging material. Generally, these findings were mirrored the effect of added fruits pulp and syrup on minimization of moisture content which is considered important parameter of sheets quality, especially during storage period.

3.3 Ash:

Regarding ash content, the obtained results indicated that there are significant differences ($P< 0.05$) between samples P_B and P_T. Sample P_B which is treated with (60% pumpkin + 20% baobab syrup) recorded the highest ash content (3.25%) followed by samples P_T (3%), P_M and P (2.75%).The increase of ash content can be explained by the ash content of the original sample which is refer to the minerals content. (Elinge *et al.*, 2012) stated that samples with high ash content are expected to have high concentration of various mineral elements, which are expected to speed up metabolic processes, improve growth and development.

3.4 Crude Protein:

The obtained findings of protein revealed that there were no significant differences ($P< 0.05$) between all treated samples. The sample treated with pure pumpkin pulp (Sample P) possessed the highest protein content (2.25%). Such amount is more closed to that recorded by sample P_T (2.20%), whereas samples P_M and P_P recorded (2.15%) and (2.10%), respectively. Nevertheless, the protein results of current research confirm the fact that fruits and vegetables are low in protein content, its offer an opportunity to enhance the nutritional value of dried pumpkin sheets.

3.4 Crude Fiber:

In terms of fiber content, the prepared dried sheets were markedly influenced by the addition of different fruits mixtures, whereas, sample P_B recorded the highest fiber content (3.13%) followed by samples P_T (3.03%) and $P_{\mathbf{M}}$ (2.59%), whereas sample P recorded the lowest fiber content (2.85%).Similar observation of crude fiber increase was reported by (Atef *et al.*, 2012).According to Escalada *et al.*, (2007) fruits and vegetables are important sources of dietary fibre, although the content is not as high as in cereals. Fruits and vegetables have been shown to have high content of soluble dietary fibre. Soluble dietary fibre plays an important role in lowering serum cholesterol and glucose level, while insoluble dietary fibre is essential in maintaining intestinal health.

Table 2: Physico-chemical attributes of pumpkin pulp based sheets prepared of different fruits mixtures

Sheet Sample Mixtures	Moisture Content %	Ash %	Crude Protein %	Crude Fiber %	pH	TSS	Titeratable Acidity %	Total Sugars %	Reducing Sugars %	Non-Reducing Sugars %
P	10.75 ± 0.25^{a}	2.75 ± 0.25^{b}	2.25 ± 0.05^{a}	2.85 ± 0.05^{c}	4.41 ± 0.00^{b}	6.50 ± 0.00^{c}	2.72 ± 0.04^{c}	7.52 ' 0.26^{d}	2.08 ± 0.02^{d}	5.16 ± 0.25^{d}
P_M	7.75 ± 0.25^{c}	2.75 ± 0.25^{b}	2.15 ± 0.05^{a}	2.95 ± 0.05^{b}	4.77 ± 0.01^{a}	6.88 ± 0.13^{a}	1.44 ± 0.04^{d}	26.20 ± 0.50^{a}	4.99 ± 0.10^{b}	20.15 ± 0.39^{a}
P_T	9.75 ± 0.25^{b}	3.00 ± 0.00^{ab}	2.20 ± 0.10^{a}	3.03 ± 0.03^{b}	3.52 ± 0.01^{d}	6.75 ± 0.00^{b}	4.51 ± 0.03^{a}	21.00 ± 0.09^{b}	5.71 ± 0.05^{a}	14.52 ± 0.04^{b}
P_B	10.00 ± 0.00^{b}	3.25 ± 0.25^{a}	2.10 ± 0.10^{a}	3.13 ± 0.08^{a}	3.75 ± 0.00^{c}	6.25 ± 0.00^{d}	3.90 ± 0.13^{b}	15.13 ± 0.11^{c}	4.67 ± 0.06^{c}	9.94 ± 0.15^{c}

Mean ± standard deviation (n = 3). Mean values within a column followed by a different letter are significantly different ($P < 0.05$).

Where:

P = 80% Pumpkin pulp (Control) + 20% (LJ), (S), (GAP), (SG)

P_M = 60% Pumpkin pulp + 20% Mango pulp + 20% (LJ), (S), (GAP), (SG)

P_T = 60% Pumpkin pulp + 20% Tamarind syrup + 20% (LJ), (S), (GAP), (SG)

P_B = 60% Pumpkin pulp + 20% Baobab syrup + 20% (LJ), (S), (GAP), (SG)

3.5 pH, TSS and Titeratable Acidity:

Based on the results presented in Table 2, it is noticeable there were significant differences ($P< 0.05$) in pH value, TSS and Titeratable acidity among all treated samples. The results of pH value revealed that the sample P_M recorded the highest value (4.77) followed by the sample treated with pure pumpkin (Sample P) which is recorded (4.41). These findings are in consistence with those reported by (Adubofuor *et al.*, 2016) and it is below the range of (4.90-5.50) which are stated by (FDA, 2007) for pumpkin fruits. On the other hand, the sample treated with Pumpkin + Tamarind syrup (Sample P_T) recorded (3.52), while the sample treated with Pumpkin + Baobab syrup (Sample P_B) recorded the lowest value (3.25).This could be attributed to the addition of tamarind syrup. Due pH value considered as indication of acid content, the same sample recorded the highest Titeratable Acidity (4.51%), while, the sample treated with pumpkin pulp + mango pulp (Sample P_T) recorded the lowest Titeratable Acidity (1.44%). Akajiaku *et al.*, (2014) indicated that the tamarind fruit pulp is acidic and has an uncommon plant acid (tartaric acid).On the other hand; samples (P) and (P_B) achieved (2.72%) and (3.90%), respectively. According to Adubofuor *et al.*, (2016) the Titeratable Acidity is important for flavour balance and a low pH leads to more stable colour and inhibits microbial spoilage. Likewise, sample ($P_{\mathbf{M}}$) possessed the highest TSS (6.88%) followed by sample P_T (6.75%), sample P (6.50%) and sample P_p (6.25%). This might be referring to the high TSS percentage of added mango pulp. These outcomes encourage incorporation of popular fruits mixtures so as to correct the low soluble solids level, as well as, improving organoleptic quality of manufactured sheets.

3.6 Total Sugars, Reducing Sugars and Non Reducing Sugars:

Prominently, the addition of different fruits mixtures besides pumpkin has significant effect on sugars content of produced sheets. It could be seen from Table (2) that the total sugars of prepared samples were significantly ($P< 0.05$) higher than that prepared from pure pumpkin (Control).The total sugars of manufactured sheets were 26%, 21% and 15% for samples P_M, P_T and P_B, respectively, while sample P was achieved (7%). As mango pulp considers rich source of sugars, sample P_M achieved the highest value, as well as it is treated with high concentration of mango pulp. Accordingly, such pattern of increase was observed in reducing sugars, where sample P_T recorded the highest value (5.71%) followed by samples P_M (4.99%) and P_P (4.67%), whereas sample P recorded the lowest value (2.08%). In terms of non reducing sugars, sample $P_{\mathbf{M}}$ recorded the highest value (20%) followed by samples P_T (14%) and P_P (9%), whereas sample P recorded the lowest value (5%).Li *et al.,* (2005) showed that the active polysaccharides from the pumpkin fruit could obviously increase the levels of serum insulin, improve tolerance of glucose and hence could be developed as new anti diabetic agent.

Table 3: Minerals content of pumpkin pulp based sheets prepared of different fruits mixtures

Sheet sample Mixtures	K %	Na %	Ca %	P %
P	1.75 ± 0.05^{a}	0.52 ± 0.13^{a}	0.67 ± 0.01^{a}	0.12 ± 0.01^{ab}
P_M	1.55 ± 0.05^{b}	0.41 ± 0.01^{c}	0.61 ± 0.01^{b}	0.16 ± 0.01^{a}
P_T	1.35 ± 0.05^{c}	0.47 ± 0.02^{b}	0.59 ± 0.01^{b}	0.14 ± 0.01^{a}
P_B	1.15 ± 0.05^{d}	0.46 ± 0.02^{b}	0.59 ± 0.02^{b}	0.13 ± 0.01^{a}

Mean ± standard deviation (n = 3). Mean values within a column followed by a different letter are significantly different ($P < 0.05$).

Where:

P = 80% Pumpkin pulp (Control) + 20% (LJ), (S), (GAP), (SG)

P_M = 60% Pumpkin pulp + 20% Mango pulp + 20% (LJ), (S), (GAP), (SG)

P_T = 60% Pumpkin pulp + 20% Tamarind syrup + 20% (LJ), (S), (GAP), (SG)

P_B = 60% Pumpkin pulp + 20% Baobab syrup + 20% (LJ), (S), (GAP), (SG)

3.7 Minerals Composition:

The results of minerals content of prepared sheets were presented in Table 3.The findings revealed that there were significant differences ($P< 0.05$) among all treated samples in terms of potassium content. Clearly, it could be observed that sample P achieved the highest value (1.75%) followed by samples P_M (1.55%), P_T (1.35%) and P_B (1.15%). Likewise, sodium content of the sample treated with pumpkin (Sample P) was significantly ($P< 0.05$) higher than other treated samples which is achieved (0.52%), while, there are no significant differences between samples P_T and P_B which achieved (0.47%), (0.46%), respectively, whereas, sample P_M achieved lowest value (0.41%). Regarding calcium content, same patterns was recorded, whereas significant change ($P< 0.05$) can be noticed for the sample which is treated with pure pumpkin (Sample P) compared with other treated samples. Sample P recorded the highest calcium content (0.67%).Obviously; there are no significant changes ($P< 0.05$) among samples $P_{M,}$ P_T and P_B which recorded (0.61%) and (0.59%), respectively. On the hand, sample P recorded the lowest value of phosphors content (0.12%) compared with sample P_M which is recorded the highest value (0.16%), followed by sample P_T (0.14%) and sample P_B (0.13%).The superior trend of the sample treated with pure pumpkin pulp (Sample P) confirm the fact that pumpkin pulp is good source of minerals.

Conclusion:

The obtained data revealed that the quality attributes of prepared pumpkin pulp based sheets were affected positively by the addition of different fruits mixtures. Increase trend of ash, fiber, TSS, titratable acidity and sugars content was observed, while moisture content decreased. Pumpkin sheets containing baobab syrup recorded the highest drying ratio, ash and fiber content compared with the sheets prepared of pumpkin only. Pumpkin sheets containing mango pulp recorded the highest pH value, TSS, phosphorus and the lowest titratable acidity. It is concluded that the production of pumpkin pulp based sheets can be successfully carried out to enhance the quality attributes of the prepared sheets. Hence, the results of this work are could be help the researchers in transferring the knowledge on processing of dried sheets and it is expected to give advantageous guidance to the local communities interested in cultivating, processing and consuming the fruit pulp.

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