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ORIGINAL RESEARCH

Comparative Effects of Water and Microwave Blanching on Mineral and Anti-Nutrients Composition in Pumpkin Components

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Abstract

Pumpkins offer high nutritional benefits, though the peels and seeds are often discarded due to perceived anti-nutritional factors. However, there is need to promote utilization of the different parts through anti-nutrients reduction and development of composite flour. This study investigated the effect of water and microwave blanching on mineral content and anti-nutrient levels in pumpkin peels, pulp and seeds. The samples for the different treatments were analyzed for mineral content by Atomic Absorption Spectroscopy and Ultraviolet-Visible Spectroscopy methods while anti-nutrients were determined by titration and Ultraviolet-Visible Spectroscopy method. Pumpkin seeds had significantly higher mineral levels than peels and pulp. For the unblanched samples, copper, zinc, magnesium, iron, and phosphorus ranged from 0.86±0.27 to 1.55±0.21mg/100g, 23.81±4.71 to 32.27±0.70mg/100g, 54.27±1.44 to 91.01±0.68, 5.45±1.37 to 16.14±1.35 mg/100g, 248.57±3.18 to 312.76± 4.18mg/100g respectively in the pumpkin peels, pulp and seeds. For blanched samples copper, zinc, magnesium, iron, and phosphorus ranged from 0.33±0.02 to 0.92±0.02, 16.95±1.31 to 24.44±1.29, 16.04±2.32 to 89.76±0.32, 2.92±0.79 to 12.75±1.55, 219.90±1.42 to 276.04±1.17 in mg/100g respectively. All microwave blanched samples had significantly higher levels of minerals than the water blanched samples. Seeds had significantly higher levels of phytic acid but showed the lowest levels of tannins than the other parts. Water blanching led to higher loss of phytates, tannins and minerals compared to microwave blanching. Therefore, microwave blanching is recommended for pumpkin parts composite flour production, as it better retains minerals while reducing anti-nutrients. Utilizing peels and seeds can enhance nutrition, reduce waste, and ultimately support sustainable, value-added food processing.

Keywords: Pumpkin, microwave, blanching, anti-nutrients, minerals

INTRODUCTION

Pumpkin (*Cucurbita pepo*) are the most grown species for human consumption across the world. The cultivar *Cucurbita pepo* is widely grown in Kenya[1]. Pumpkin peels and seeds contain considerable high amounts of micronutrients and when incorporated into pumpkin pulp flour can enrich the nutrient density[3]. This could be used to mitigate against the relatively high levels of micronutrient deficiencies in Kenya, where, out of the 6.3 million children below five years, 1.13 million are stunted, and 631,196 are underweight[2] while also promoting circular utilization of pumpkin and reducing waste. Therefore, it is important to develop localized solutions to address the malnutrition problem and ensure sustainability of the solutions and easy adoption by communities within the country. The peels, pulp and seeds can undergo dehydration process followed by a milling process to develop flour that could be used for enriching diets[4]. However, pumpkins have been found to contain considerable amounts of anti-nutrients such as phytates, tannins and oxalates[5]. Some methods of food processing such as microwave heating, fermentation, boiling, germination, soaking and blanching are effective in reducing the level of anti-nutrient contents of foods[6,7]. In preparation of pumpkin for drying, blanching can be used as a pre-treatment to improve or retain product quality[8]. Water blanching is widely used as a pre-treatment method in Kenya during processing while microwave blanching is utilized in some areas as a pre-treatment method for fragile vegetables such as broccoli[9]. Extensive research has been done to determine effect of different blanching methods on nutrient retention in vegetables with a focus on ultraviolet treatment, irradiation and ohmic heating which are not extensively used in the Kenyan set up. Blanching is a more common pre-treatment method in Kenya but there is limited information on the effect of different blanching methods on nutrients and specifically on the mineral and anti-nutrient contents of the different parts of pumpkin fruit for flour formulation. It is hypothesized that there is no significant difference in the mineral and anti-nutrient composition of the flour made from differently blanched pumpkin parts. Therefore, this study aimed at determining the effect of microwave and water blanching on mineral and anti-nutrient contents of flour made from different pumpkin parts.

MATERIALS AND METHODS

Research design: The research employed experimental design.

Sample collection and preparations: Pumpkins were obtained from Dedan Kimathi University of Technology (DeKUT), Nyeri, Kenya, demonstration farm. A simple random sampling technique was used to select the mature pumpkins to be used in the research. They were harvested at maturity (6 months) and taken to DeKUT Food Science Workshop where they were weighed, washed, rinsed and separated into different parts that included the peels, pulp and seeds. Completely Randomized Design (CRD) was used in preparation of treatments. The samples for each part, each weighing approximately 1500g, were prepared in triplicate. The different parts were subjected to both water and microwave blanching as follows: For water blanching, samples of different pumpkin parts were placed in a stainless-steel food strainer and dipped in boiling water at 93°C for 120 seconds. For microwave blanching, samples of the different parts of pumpkin in 500 ml beakers were placed in a microwave (Ramtons 700W output RM 237) for 120 seconds[10]. After the blanching, the samples were dipped in cold water for one minute and then drained and placed on blotting papers. Subsequently, the blanched samples were placed in a hot air oven to dry at 60°C. The samples were dried for 7 days, then milled to flour using a spice grinder of 220V 3400r/min (Zhejiang Boou Electric Company Limited, Model Number 800Y). It was then sieved through 250 microns sieve, packaged in labeled polypropylene bags and stored in a clean, dry place until the time for chemical analysis. All treatments were prepared in triplicates.

Determination of mineral content: The minerals determined in the research were purposively selected based on the Kenya Micronutrient Survey[11] that considers them minerals of concern in Kenya. Mineral determination was done following the method described in AOAC method number 985.01[12]. For each sample, 5g was taken and subjected to dry ashing in a muffle furnace at 550°C. Approximately 1g was dissolved in a volumetric flask using 0.5N Nitric acid and diluted up to 100ml volume. One milliliter (One milliliter (1 ml)) of the diluted sample was aspirated into Shimadzu7000 Atomic Absorbance Spectrophotometer. The level of intensity of radiation emission for potassium and sodium was obtained from the measurement. For magnesium, zinc and iron, the level of radiation absorbance was obtained from the measurement. The hollow-cathode lamps specific to each element were used as radiation source each emitting specific wavelength needed for each mineral. Standard solutions for each element were run under the same conditions and the standard curves for absorbance and emission versus concentration for each mineral were used to calculate the levels for each mineral in the samples.

Phosphorus was determined using UV-VIS (Model UV-1900i Shimadzu, Japan). Specifically, one milliliter (1 ml) of the diluted and filtered solution was pipetted into a clean test tube and 3 drops of 0.5% p-nitro phenol indicator added. It was mixed with 6N ammonia solution by adding dropwise until the color turned yellow. Nitric acid (1N) was also added dropwise until the solution decolorized. Then, 1 ml of ammonium molybdate was added and allowed to stand for 15 minutes for color development. The solution absorbance was then read at

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450nm in UV-VIS Spectrophotometer. A standard curve was constructed using commercial phosphorus standard in the range of 0 to 20ppm. The standard curve was then used to determine the phosphorus content of the samples.

Anti-nutrients determination

Determination of phytates was done using the method described by Nzotta and Onabanjo [13] with minor modifications. Two grams (2g) of flour sample were placed into a two hundred and fifty milliliters (250 ml) conical flask, and a 100 ml of 2% Hydrochloric acid were added to soak the sample for 3 hours. The mixture was then filtered through a Whatman Filter Paper 42 to obtain the filtrate. Ten milliliters (10 ml) of the filtrate were placed in a two hundred and fifty milliliters (250 ml) conical flask and 10 ml of distilled water was added in each case to adjust the acidity. Ten milliliters (10 ml) of 0.3% Ammonium Thiocyanate solution were also added into each solution and then titrated with standard iron (III) chloride solution that contained 0.00195g iron per ml. The end point was slightly brownish-yellowish persistent color for 5 minutes. The amount of phytic acid was calculated using the formula:

$$\% \text{ Phytic Acid} = \frac{\text{Titrated value} \times 0.00195 \times 1.19 \times 100 \times 3.55}{\text{Wt. of Sample}}$$

Determination of tannins in the sample was done according to Nzotta and Onabanjo[13]with a few modifications. Two grams (2g) of the samples were weighed into a beaker and soaked with a solvent mixture of 80 ml acetone and 20 ml glacial acetic acid for 22 hours to extract tannin. It was then placed in a water bath at 40°C for 3 hours. A set of tannic acid standard solutions was prepared ranging from 10ppm to 50ppm. The standard solution was prepared by adding 0.1 mg in 100 ml of methanol and making serial dilutions of 10 ppm, 20 ppm, 30ppm, 40ppm and 50 ppm. The absorbencies of the standard solution as well as that of the filtrates were read at 270 nm on a spectrophotometer (Model UV-1900i Shimadzu, Japan).

Data analysis: Data obtained was analyzed using Minitab Release 18 Software (Minitab Inc. Pennsylvania, USA). Considering pumpkin parts and blanching methods as source of variation, the data obtained was subjected to one way analysis of variance (ANOVA), and the means were considered significantly different at $p < 0.05$, and results were expressed as the mean ± standard deviation (SD). Fisher LSD was used to separate the means for those that showed significant differences.

Ethical considerations: The ethical approval for the data collection was obtained from Dedan Kimathi University of Technology Scientific Ethical Review Committee. The research permit was obtained from the National Commission for Science and Technology, and Innovation (NACOSTI).

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RESULTS AND DISCUSSION

Mineral content

The mineral content for copper, zinc, magnesium, iron, calcium, sodium, potassium and phosphorus of the different parts of pumpkins is presented in Table 1.

Table 1: Mineral composition (mg/100g) of the differently blanched dehydrated pumpkin parts.

Blanching	Pumpkin part	Cu.	Zn.	Mg.	Fe.	Ca.	Na.	K.	P.
Unblanched	Skin	1.12±0.20^{b}	23.81±4.71^{d}	54.27±1.44^{c}	5.50±0.72^{d}	22.37±1.63^{cde}	19.22±0.14^{b}	173.42±3.10^{a}	258.88±0.42^{c}
	Pulp	0.86±0.27^{cd}	27.43±2.37^{bc}	57.37±1.46^{c}	5.45±1.37^{de}	54.50±2.22^{a}	27.53±1.72^{a}	172.02±0.37^{ab}	248.57±3.18^{de}
	Seeds	1.55±0.21^{a}	32.27±0.70^{a}	91.01±0.68^{a}	16.14±1.35^{a}	25.64±2.21^{c}	17.94±1.79^{b}	128.07±0.75^{e}	312.76±4.18^{a}
Microwave blanched	Skin	0.45±0.12^{ef}	18.55±1.59^{ef}	44.78±4.78^{e}	4.45±0.34^{def}	18.08±2.02^{def}	12.84±0.10^{d}	169.36±0.07^{b}	258.12±0.76^{c}
	Pulp	0.45±0.12^{cf}	21.00±0.5^{de}	54.35±0.92^{c}	4.78±0.60^{de}	39.69±8.01^{b}	12.82±0.11^{d}	141.14±0.98^{d}	234.50±1.77^{f}
	Seeds	0.92±0.02^{bc}	29.40±0.9^{ab}	89.76±0.32^{a}	12.75±1.55^{b}	23.11±2.63^{cd}	15.71±0.07^{c}	110.80±0.61^{f}	276.04±1.17^{b}
Water blanched	Skin	0.33±0.02^{f}	18.40±1.39^{ef}	16.04±2.32^{f}	2.92±0.79^{f}	7.35±0.20^{g}	12.78±0.13^{d}	154.85±3.88^{c}	248.87±0.52^{d}
	Pulp	0.33±0.06^{f}	16.95±1.31^{f}	49.21±0.84^{d}	3.79±0.30^{ef}	16.53±1.73^{ef}	12.68±0.14^{d}	139.59±0.87^{d}	219.90±1.42^{g}
	Seeds	0.67±0.01^{de}	24.44±1.29^{cd}	86.24±0.85^{b}	10.86±0.90^{c}	13.95±4.37^{f}	12.61±0.02^{d}	102.43±0.29^{g}	245.13±0.66^{e}

Values mean ± standard deviation. The means sharing the same letters in columns are not significantly different from each other (p <0 .05).

Copper

Pumpkin seeds contained significantly higher levels of copper than the peels and pulp an indication that the seeds are richer in copper compared to the other parts of pumpkin. However, all blanched pumpkin parts had significantly lower copper levels, with water blanching showing the lowest levels. Therefore, blanching pumpkin parts can significantly reduce the levels of copper content. Specifically, water blanched samples showed a reduction of copper levels between 43.2 to 70.59% in the different pumpkin parts while microwave blanching showed a reduction of between 40.8 to 59.5%. The higher losses for water blanched samples could be associated with leaching of copper into the water used for blanching. This is in agreement with research conducted on beans, where 26% loss of copper was observed after water blanching[14]. There was less reduction of copper in the seeds compared to the peels and pulp which could be attributed to the seed coat barrier that might have led to reduced loss during blanching[14]. However, in contrast to this, Panda et al.[15] showed an increase in copper content among edible bamboo shoots when subjected to water blanching which was linked to the denaturation of copper containing enzymes that are highly present in the shoots.

Zinc

The zinc content in the seeds was significantly higher than in the peels and pulp. Specifically, the level of Zinc in the seeds, peels and pulp was 32.27±0.70mg/100g, 23.81 ±4.71 mg/100g, and 27.43 ± 2.37 mg/100g, respectively (Table 1). This shows that the seeds are richer in zinc content as compared to the pulp and peels which is in agreement with the findings of Hussain et al.[14] who indicated a level of 15.21mg/100g of Zinc in pumpkin seeds and also ranked pumpkin seeds to have highest Zinc content followed by flesh and peel, in that order. However, this study obtained higher values for the zinc content compared to those reported by Amin et al.[17] who found a level of 0.15 mg/100g and 18.78mg/100g in pumpkin peels and seeds, respectively. The differences could be attributed to the different pumpkin varieties used and geographical conditions[17].

The blanched samples showed significantly lower levels of zinc content compared to the unblanched samples. Lower levels of Zinc in the water blanched samples could be attributed to the loss of the mineral through leaching to the water. However, for microwave blanching, the slight reduction in zinc content could be associated with drip loss involved after blanching[18]. The amount of loss was lower than the 34.8% reduction in Zinc reported for water blanched *Amaranthus hybridus* and *Basella alba*[19]. The findings of this study contradict those of Mishra et al.[12] who showed that blanching has no effect on the zinc content of foods. There was higher retention of Zinc with microwave blanching in seeds compared to pulp and peels, in that order, while for water blanched samples the seeds and peels showed slightly higher retention than the pulp. The amount of zinc retained in the blanched samples varied between 16.95 to 29.40 mg/100g and was within 75% of the recommended daily allowance (RDA) which is 11mg per day for adults and pregnant women and 12mg per day for lactating mothers[20,21].

Magnesium

The level of magnesium was highest in the seeds followed by the pulp while the peels showed the lowest amounts. The unblanched samples showed 54.27±1.44, 57.37±1.46 and 91.01±0.68 mg/100g for the peels, pulp and seeds, respectively. There was a significant difference ($p<0.05$) in magnesium content between the unblanched samples and the blanched samples. However, the unblanched and microwave blanched samples did not show any significant difference except for the peels. The magnesium levels in the unblanched peels and pulp were not significantly different ($p>0.05$). Water blanching resulted in higher magnesium reduction percentages compared to microwave blanching, which is in agreement with the findings of Asaolu & Asaolu[22] who found that minerals are significantly lost with water blanching depending on the time-temperature combination of the blanching procedure. In this study, there was a 14.2% loss of magnesium with water blanching in the pulp samples. These data tallies with research that found that water blanching results in 17.3% and 12.3 % loss in magnesium for Okra and green beans, respectively [23]. From the magnesium levels, it is apparent that blanching results into higher retentions of magnesium for the pulp and seed while highest losses occur in the peels. But water blanching is seen to result in more loss compared to microwave blanching which could be attributed to the leaching of magnesium in the blanching water[24].

Iron

The iron levels in the pumpkin were 5.50mg/100g, 5.45mg/100g and 16.14mg/100g for the unblanched peels, pulp and seeds, respectively, with the highest iron levels being in the seeds followed by peels and then pulp. These findings vary with those reported by Hussain et al.[25] who indicated a level of 4.05mg/100g, 41.50mg/100g and 6.16 mg/100g in the peels, pulp and seeds, respectively, of pumpkins (*Curcubita maxima*). This showed that the pulp contained the highest iron content compared to the peels and the seeds. However, the values obtained for pumpkin seeds are higher compared to those of 8.8mg/100g and 6.16mg/100g obtained by Syed et al.[26] and Hussain et al.[25]. The differences in the amounts of iron may be attributed to the difference in pumpkin varieties involved in the various studies and the varied geographical location[27,28]. Blanching resulted in significant reduction of the levels of iron content in the different pumpkin parts. The water blanched samples showed a maximum reduction of 46% in iron levels in the peels which was comparable with the 41.4% reduction in iron among water blanched *Amaranthus hybridus* and *Basella alba*[19].

The higher losses with water blanching are attributed to the leaching of iron in water which aligns with a study showing that water blanching and boiling had the highest iron losses when compared to steam blanching, and microwave blanching[27]. The 21% reduction in iron levels in the microwave blanched seeds samples can be attributed to interaction with other chemical composition in the seeds. Despite the blanching involved, the amount of iron in pumpkin parts at 100g can play a vital role in meeting the recommended daily allowance (RDA) for minerals. The RDA for iron for men and post-menopausal men and pre-menopausal women is 8mg/day and 18mg/day, respectively. The least iron content was in the pumpkin peels at 2.92mg/100g which could also meet 36.5% and 16.2% of the RDA for men and pre-menopausal women, respectively[28].

Calcium
The range for calcium content in the pumpkin parts was 22.37 mg/100g to 54.50mg/100g in the unblanched samples. These ranges are different from the ranges of 1.49mg/100g to 5.67mg/100g for the pumpkin parts reported by Hussain et al.[25]. The pumpkin part with the highest calcium content was the pulp followed by seeds and peels which also differed from the findings by Hussain et al.[26] which showed that the seeds had the highest calcium followed by the pulp and then the peels. The study showed a level of 54.50mg/100g of calcium in the pulp which is slightly higher, to a level of 46.35mg/100g in pumpkin grown in Egypt and reported by El-Demery[29]. The levels of calcium in the peels and seeds were not significantly different from each other but they were significantly different from that of the pulp.

There was a significant difference ($p<0.05$) between the unblanched and the water blanched seed samples. Specifically, the seeds that were water blanched showed a 45.6% reduction of the calcium content. This is in agreement with research findings by Mishra et al.[14] which showed that calcium losses were around 40%, which is highest compared to losses of copper, manganese and iron after water blanching. This however contradicts with the finding of Nur et al.[23] who found that calcium is hardly lost during water blanching because the mineral tends to be tightly bound to the plant tissues compared to other minerals. Therefore, it is possible that the calcium losses during blanching are dependent on the food item and their interaction with other chemical compounds in that food.

Sodium
The sodium ranges for pumpkin parts were 19.22mg/100g to 27.53mg/100g in the unblanched samples. The pumpkin part with the highest sodium was the pulp, followed by the peels and then the seeds. However, sodium levels in the peels and seeds were not significantly different from each other. The highest losses in sodium levels were experienced in the pulp followed by the peels and then the seeds. There were significant differences in sodium content between unblanched and blanched samples with relatively higher losses in water blanched samples. The relatively higher loss with water blanching could be attributed to osmotic pressure and leaching into the blanching water. On the other hand, the higher retention of sodium in the microwave blanched samples could be attributed to the uniform heating, reduced water contact and the internal heating and hence minimizing the loss of sodium[29,30].

Potassium
The potassium levels in the unblanched samples ranged from 128.07mg/100g to 173.42mg/100g. The pumpkin part with the highest potassium was the peels followed by the pulp and then the seeds. However, the potassium levels in the pulp and the peels were not significantly different from each other. This agrees with a study that showed pumpkin pulp contained higher amounts of potassium than the pumpkin seeds[17]. There was a 13.5% and 20% reduction in potassium levels in the seed samples with microwave blanching and water blanching, respectively. These results are similar to those of Panda et al.[15] that found that potassium undergoes more leaching in water blanching compared to steam blanching and microwave blanching. The highest potassium losses were in seeds followed by pulp flour then peels flour an indication that the different chemical composition of the flour may influence the potassium retention capacity[24].

Phosphorus
The phosphorus levels in pumpkin parts ranged from 219.90 mg/100g to 312.76mg/100g. The pumpkin part with the highest phosphorus was the seeds followed by the peels then the pulp. These results agree with findings by Batool et al.[3] who found pumpkin seeds to have highest content of phosphorus. The pumpkin peels showed a 0.5% and 3.9% loss of phosphorus with microwave blanching and water blanching, respectively. For pumpkin pulp, there was a 5.7% and 11.5% loss with microwave blanching and water blanching, respectively. The highest losses in phosphorus were seen for the seeds which had an 11.7% and 21.6% loss with microwave blanching and water blanching, respectively. The varied losses in the pumpkin parts could be attributed to the cellular composition difference in the parts which interact differently with minerals[24].

Antinutrient composition of different pumpkin samples

Results for antinutrient contents of different pumpkin parts are presented in Table 2. They included phytates as phytic acid and tannins as tannic acid.

Table 2: Anti-nutrient composition of the differently blanched dehydrated pumpkin parts.

	Seeds		Pulp		Peels	
Treatments	Phytic Acid (%)	Tannic Acid (mg TAE/100g)	Phytic Acid (%)	Tannic Acid (mg TAE/100g)	Phytic Acid (%)	Tannic Acid (mg TAE/100g)
Unblanched	19.11 ±0.29^{a}	114.63 ±0.74^{abc}	5.86 ±0.57^{d}	116.57±0.78^{a}	5.34±0.09^{d}	116.24±2.66^{ab}
Microwave blanched	12.27 ± 0.43c	114.46±0.62^{abcd}	3.57±0.29^{e}	114.63±0.45^{abc}	3.71 ±0.38^{e}	114.22±1.59^{bcd}
Water blanched	16.05±0.91^{b}	112.39±0.45^{d}	3.34± 0.41^{e}	113.26±1.80^{cd}	4.12±0.72^{e}	112.61±0.69^{cd}

Values are means ± standard deviation. The means sharing the same letters in columns are not significantly different from each other (p <0 .05).

Phytates

The phytic acid content in the different pumpkin parts ranged from 3% to 19%, with the seeds showing the highest levels. These values were relatively higher compared to the range of 3- 6% reported by Mohammed et al.[32] whose results indicated that the pulp had the highest levels of phytates followed by the peels and then the seeds. However, this research showed no significant differences in phytate levels in pumpkin peels and pulp but showed significant differences with the seeds which had highest level of phytic acid. This could be attributed to the fact that phytic acid is the storage form of phosphorus in pumpkin fruits and usually accumulates in the seeds during maturity [33]. Blanching is generally associated with a decrease in phytic acid in plant foods [34]. In this study, blanched samples showed a decrease in the phytic acid content in the pulp, peels and seeds. For the peels and pulp, there was a significant difference ($p<0.05$) between the blanched samples and the unblanched sample, but the microwave blanched, and water blanched samples for peel and pulp did not show any significant differences. Both microwave and water blanching contributed to the reduction of phytic acid content in the peels by around 30 % and 22 %, respectively. For the pulp, there was 43% and 39% reduction in phytic acid content with water and microwave blanching, respectively. However, the effect of blanching was lower than that reported by Cheng et al.[35] on dehulled beans, in which microwaving for 2 minutes was associated with a 55% reduction in phytic acid content.

Microwave blanching of the pumpkin seeds for 120 seconds resulted in a 35.8% reduction in phytic acid content. This indicates that microwave blanching could be an effective and efficient method for the reduction of phytic acid in different pumpkin parts. Hence, utilization of microwave heating for pre(processing), cooking, or drying could provide a convenient, rapid heating and energy efficient way of reducing anti-nutritional factors, for both small-scale and large-scale production[36].

Tannins

Tannin values for the different pumpkin parts were obtained as Tannic Acid Equivalent (TAE) in mg/ 100g of the samples. The level of tannic acid in the unblanched samples were 114.63 mg/100g, 116.24mg/100g and 116.57mg/100g in the seeds, peels and pulp, respectively. The tannic acid content of seeds was lower compared to 3.14% (3140mg/100g) obtained by Tagwi et al.[37] and also lower compared to the 2.04% (2047 mg/100g) TAE obtained by Ethiraj & Balasundaram[38]. The 116.57mg/100g of TAE obtained for the pulp was higher compared to the 53.09mg/100g obtained by Adubofuor et al.[39].

There was a significant difference ($p<0.05$) between the tannin content of the unblanched, and water blanched samples. This indicated the effectiveness and efficiency of water blanching in reduction of tannins in the pulp, peels and seeds of pumpkin. The levels of tannins in the pumpkin peels, pulp and seeds samples in this study were within the safe limits, which are 1.5-2.5g/ day per serving of whole pumpkin, showing pumpkin ultimately as a nutritious and safe food option [40]. The reduction of tannins in the blanched samples was less than 5%, indicating that more time is needed during pre-treatment to achieve a further reduction in the tannin levels in the various pumpkin parts. The values for the peels and seeds are relatively lower compared to the 2.84mg/g and 2.94mg/g obtained by Mohammed et al.[32]. However, the values are relatively higher for pumpkin pulp compared to the 0.84mg/g obtained by Mohammed et al.[32].

CONCLUSION

The various pumpkin parts are a rich source of minerals which can improve the nutrient density of diets when the anti-nutrient levels are reduced. Through microwave blanching and water blanching, the phytate and tannins levels are reduced to acceptable levels. Microwave blanching retains more than 70% of minerals compared to water blanching. Microwave blanching is therefore a suitable pre-treatment method that needs to be utilized in the development of pumpkin flours to reduce the anti-nutrient levels in the pumpkin peels, seeds and pulp. Through circular utilization of the pumpkin fruit, nutrient dense products can be developed to aid in sustainable solutions of micronutrient deficiencies in middle and low income countries. Further research is needed to determine how other forms of blanching aid in retaining the micronutrient quality of different pumpkin parts in flour formulation. It is recommended that microwave blanching is utilized as a pretreatment in flour development of the different pumpkin parts to improve nutrient availability and reduce waste.

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Conflict of interest disclosure:

The authors report no conflict of interest.

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