Physical-Chemical Properties, Storage Stability and Sensory Evaluation of Pumpkin Seed Oil

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Abstract: *Physico-chemical properties, storage stability and sensory evaluation of pumpkin seed oil was carried out and compared with other vegetable oils commonly used in Tanzania in order to evaluate its potential as an edible oil with the aim of promoting its utilization in rural areas. Pumpkin seeds were collected from different farmers in three villages in Morogoro Region, Tanzania. The proximate composition of the seeds was determined using standard methods. Storage stability of the oil was evaluated by monitoring the physical-chemical properties of the oil for 15 weeks following the standard procedures. Acceptability of the oil was determined using a 5 point hedonic scale. Pumpkin seeds contained 34.7%, 15.9%, 3.85% and 44% protein, fat, fibre and carbohydrates, respectively. The specific gravity of the pumpkin seed oil was 0.92; peroxide value 4.6 meq/kg; iodine value 108.4; saponification value 173.0 and acid value of 0.5 mg KOH/g. The pumpkin seed oil was organoleptically acceptable in terms of flavour, taste and odour. The pumpkin seed oil conforms very well with other common edible vegetable oils in Tanzania in terms of physical-chemical properties and sensory evaluation. Farmers should be encouraged to utilize pumpkin seed oil for household consumption.*

Key words: pumpkin seed oil, sensory acceptability

INTRODUCTION

Pumpkin is a large melon fruit, which grows in the tropics and temperate regions which belong to the family Cucurbitaceae. The. The principal species cultivated include, *Cucurbita pepo*, *Cucurbita moschata*, *Cucurbita maxima*, *Cucurbita. turbaniformis, Cucurbita orggyrosperma* and *Cucurbita ficifolia* (Gemrot *et al.*,2006).Pumpkin leaves and fruits are widely used in Africa. The pumpkin seed is valued in regard to nutritional points. Several studies have reported the chemical composition and oil characteristics of the pumpkin seed from different origins and varieties (Stevenson *et al.,* 2007). The four fatty acids presented in significant quantities are palmitic, stearic, oleic, and linoleic acids (Stevenson *et al.,* 2007)

Raw or roasted pumpkin seeds are used as a snack food for human consumption in many cultures all over the world. The kernels of pumpkin seeds have been utilized as flavor enhancers in gravies and soups, and used in cooking, baking and ground meat formulations as a nutrient supplement and a functional agent (El-Adawy and Taha, 2001). The oil of pumpkin seeds are being used as a cooking oil in some countries in Africa and the Middle East, and as a salad oil in the south of Austria and the adjacent regions in Slovenia and Hungary (Wenzl *et al.*, 2002). The pumpkin seeds possess valuable dietary and medicinal qualities besides being the source of good-quality edible oils.

Pumpkin oil seeds are reported to deteriorate during storage although loss of viability is of little significance in seeds to be processed. However, utilization of pumpkin seed oil is limited to few areas of Africa. Available information shows that limited studies have been carried out to evaluate the quality of the oil. Currently, Tanzania is importing a considerable amount of refined oil and semi-refined vegetable oil in order to meet the domestic demand. Most of oil processing industries in Tanzania are therefore working under capacity because the commonly used oil seeds like sunflower, sesame and cotton are only available within a short period of time every year. Exploitation of other sources of vegetable oil is necessary to remedy the situation. Therefore, the aim of this study was to establish the physical-chemical characteristics, storage stability and sensory evaluation of pumpkin seed oil in order to promote its utilization especially in rural areas.

MATERIALS AND METHODS

Materials

Dried pumpkin seeds previously collected from different plants in two seasons and stored for 4 months were obtained from local farmers in three villages namely: Pangawe, Mlali and Misongeni in Morogoro region, Tanzania. Two types of vegetable oil commonly used in Tanzania, namely: sunflower and palm oil were purchased from PIRAS cash and carry supermarket in Morogoro and potato were purchased from Morogoro Municipal Market.

Methods

Preparation of the seeds

Pumpkin seeds were winnowed and screened to separate them from debris, foreign matters, light seeds and other extraneous materials.

Extraction oils from pumpkin seeds

Oil from the clean seeds was extracted using a semi-continuous hand powered high-pressure machine with a piston diameter of 30 mm manufactured by Carmatec (Arusha Tanzania).

Analysis of the pumpkin seeds and extracted oil

Proximate composition of the pumpkin seeds was determined in triplicate using the standard procedure of Association of Analytical Chemist Method (AOAC) (1990). Protein content by Macro-Kjeldahl method using a factor of 6.25, fat content by Soxhlet extraction method, crude fibre content by dilute acid hydrolysis and moisture content was determined by oven dry method at 103°C for 1.5 hour. Acid value was measured by titrimetric method; iodione value by Wijs' method of titration using sodium thiosulphate; peroxide value by titration using thiosulphate solution; saponification value by titrimetric method and specific gravity was calculated as a ratio of the weight of oil sample to the weight of an equal volume of water. Analysis of sunflower seed oil and palm oil was carried out in the same way for comparison.

Storage stability test of the pumpkin seed oil

A volume of 200 ml pumpkin seed oil was measured into 500 ml plastic bottles with lids and stored at room temperature (about 26°C) for a period of 15 weeks. Samples were taken for determination of peroxide and acid value at an interval of three weeks.

Sensory evaluation of the pumpkin seed oil

Acceptability of the pumpkin seed oil was evaluated using 5-point hedonic scale (Watts *et al*., 1989). The extracted oil was used to fry potato chips. Other commonly used vegetable oils like sunflower and palm oil were also used to fry potato chips in order to make a comparison. The chips fried with these oils were coded with different numbers before being presented to the panelists. A total of 12 women and 8 men of the age between 23 – 36 were used to evaluate the samples served on disposable plates at room temperature. The panelists were provided with a glass of clean water to rinse their mouths between each sample testing.

Statistical analysis

Data obtained from storage stability test was analysed using analysis of variance (Snedecor and Cochran, 1989) using MSTAT C statistical package. The data for sensory evaluation was analysed using the procedure described by Watts *et al*., (1989).

RESULTS AND DISCUSSION

The results for proximate composition in Table 1 show that pumpkin seeds used in this study were rich in protein, crude fat, and

carbohydrates. The protein content of the pumpkin seed from the present study was higher than those of other oilseeds such as cashew nuts (22.8%), cottonseed (21.9%), and sesame (18.7%), and that of animal proteins (16.0-18.0%) such as lamb, fish, and beef (Ajayi *et al.,* 2006). The protein content of the pumpkin seed suggests that it can contribute to the daily protein needs of 23.6 g/100 g for adults as recommended by some authorities (Ajayi *et al.,* 2006).

Table 1: Proximate composition of pumpkin seeds

Parameter	g/100g
Crude protein	34.7 ± 0.06
Fat	15.9 ± 0.10
Crude fibre	3.8 ± 0.06
Ash	2.2 ± 0.03
Moisture	6.3 ± 0.02
Carbohydrate	44.3 ± 0.03

Means ± Standard error of two independent determinations

The results shown in Table 2 indicate that the specific gravity of the pumpkin oil was the same as that of sunflower and palm oil. The specific gravity of the pumpkin seed oil of 0.92 ± 0.01 compares to the reported range of 0.903-0.926) and was also comparable to that of coconut (0.908-0.921), rapeseed (0.910-0.920), and canola (0.914- 0.920) oils (Nichols and Sanderson, 2003).

Table 2. Characteristics of different types of vegetable oils

Type of oil	Specific gravity	Peroxide value (meq/kg oil)	Iodine value	Saponification value	Acid value (mg KOH/g)	Moisture (%)
Pumpkin	0.92 ± 0.01	4.6 ± 0.01	108.4 ± 0.03	173.9± 0.05	0.5 ± 0.01	0.15 ± 0.01
Sunflower	0.92 ± 0.01	5.6 ± 0.03	110.2 ± 0.05	190.0 ± 0.05	0.6 ± 0.01	0.16 ± 0.01
Palm	0.92 ± 0.01	5.4 ± 0.05	110.0 ± 0.05	192.0 ± 0.06	0.6 ± 0.01	0.16 ± 0.01

Values are means ± Standard error of two independent determinations

The physical-chemical characteristics of the pumpkin and other two commonly used oils (sunflower and palm) in Tanzania are shown in Table 2. The iodine values of 108.4 ± 0.03 observed for pumpkin seed oil is close to 105.1 reported by Alfawaz (2004). The iodine values in Table 2 are comparable to those reported earlier by other workers including (Matsui *et al*., 1998) who observed that oil including soybean, cotton, sesame, sunflower, and olive oils have iodine number ranging from 80 – 110.The results obtained in this study suggest that pumpkin oil belongs to non drying oils. Non drying oils have an iodine value of less than 100 while drying oils have iodine values of 130 – 200 and semi-drying oil have intermediate values. Iodine value is a quantitative measure of the unsaturation. Usually low iodine number indicates low levels of free

fatty acids unsaturation in the triglyceride molecule hence few reactions characteristics of double bonds.

The results in Table 2 show that saponification value of pumpkin seed oil was lower than that of sunflower and palm oil. Saponification value is an index of molecular size of free fatty acids in the oil and is used in detecting oils which contain a high proportion of lower fatty acids. Saponification values are reported to differ with the type of oil and vary even for the same oil. For example, Al-Khalifa (1996) reported 200-218 range, while El-Adawy and Taha (2001) reported 206 and Tsaknis *et al.* 1997 reported 201 mg KOH/g oil respectively for *Cucurbita* species. These results suggest that the molecular size of the free fatty acids in pumpkin oil compares well with that of other oils. Molecular size of fatty acids of oils and fats has an influence on firmness of fats or oils as well as flavour and odour properties. Acid value for pumpkin seed oils was similar to that of sunflower and palm oil (Table 2). Acid value for pumpkin seed oils also compared well with that of other edible vegetable oils like groundnut oil, olive, and rape seed oils as reported by (Younis *et al*., 2000).

The results for storage stability of the pumpkin oil in comparison with sunflower and palm oil are shown in Table 3. It was observed that peroxide values for pumpkin seed oil, sunflower and palm oil increased slightly during the first six weeks of storage thereafter; there was a steady increase up to fifteen weeks (Table 3). The peroxide value of vegetable oils is an index of its status of preservation. The results of the present study show that pumpkin seed oil had peroxide value of 4.6 meq/kg which increased during storage up to 11.6 meq/kg probably because the pumpkin oil samples were kept at room temperature and exposed to light and oxygen. Also containers used for pumpkin oil were not air tight compared to those of sunflower and palm oils which were kept in sealed containers. However, it is worth noting that the rate of peroxidation differs from oil to oil depending on the different treatments to which the oils were subjected. These observations are similar to those reported by Kamau and Nanua (2008) who observed an increase in peroxide value with storage in locally produced Kenyan sunflower oil. Although peroxide value of pumpkin oil increased during storage for 15 weeks the values did not reach 20 meq /kg suggesting that the pumpkin oil was of good quality since the lower the number of peroxides, the better is the vegetable oil quality and its status of preservation. It has been reported that oils become rancid when the peroxide value ranges from 20.0 to 40.0 meq /kg oil (Ajayi *et al.,* 2006).

Table 3. Effect of storage on peroxide value of pumpkin, sunflower and *palm* oil, stored at room temperature (mg KOH/g**)**

	Time (weeks)					
Type of oil	0	3	6	9	12	15
Pumpkin	4.6 ± .01	4.8 ± 0.01	4.9 ± 0.01	10.4 ± 0.04	11.2 ± 0.01	11.6 ± 0.01
Sunflower	5.6 ± .04	5.7 ± 0.01	5.9 ± 0.01	5.8 ± 0.02	6.2 ± 0.02	7.5 ± 0.01
Palm	5.2 ± .01	5.3 ± 0.01	5.5 ± 0.01	10.6 ± 0.01	11.2 ± 0.02	11.8 ± 0.01

Values are means ± Standard error of two independent determinations

Acid values for pumpkin seed oil, did not change during the first nine weeks of storage. This was followed by slight increase up to 0.9 mg KOH/g after the fifteen weeks of storage, however, there was no change in acid value in sunflower and palm oil during the whole storage period (Table 4). An increase in acid value in pumpkin oil after nine weeks of storage could be attributed to inadequate processing and storage conditions of this oil compared to the other two industrially processed oils. Increase in peroxide and acid values in oils during storage has been reported to be due to the formation of oxidation products such as peroxides which may lead to oxidative rancidity and formation of compounds like ketones, aldehydes and short chain fatty acids. These compounds are responsible for off flavour and odour, when oils are stored at high temperatures in the presence of light and oxygen (Ajayi *et al*., 2006).

Table 4. Effect of storage on acid value of pumpkin, sunflower and palm oil stored at room temperature (mg KOH/g**)**

	Time (weeks)					
Type of oil	0	3	6	9	12	15
Pumpkin	0.5 ± 0.01	0.5 ± 0.02	0.5 ± 0.02	0.5 ± 0.02	0.7 ± 0.02	0.9 ± 0.02
Sunflower	0.6 ± 0.02	0.6 ± 0.02	0.6 ± 0.02	0.6 ± 0.02	0.6 ± 0.01	0.6 ± 0.01
Palm	0.6 ± 0.02	0.6 ± 0.02	0.6 ± 0.02	0.6 ± 0.01	0.6 ± 0.01	0.6 ± 0.02

Values are means ± Standard error of two independent determinations

Sensory evaluation of the pumpkin seed oil showed that there was no significant difference ($P < 0.05$) in taste, odour, flavour, and overall acceptability between chips fried in pumpkin seed oil, palm oil or sunflower oil (Table 5). These observations suggest that pumpkin seed oil is organoleptically acceptable as other commonly used vegetable oils.

Table 5 Mean scores of sensory evaluation of potato chips fried with different types of vegetable oils

Sample	Taste	Flavour	Odour	Overall
Potato chips fried with pumpkin oil	4.3[a]	4.1[a]	4.0[a]	3.9[a]
Potato chips fried with palm oil	3.8[a]	3.9[a]	3.9[a]	3.9[a]
Potato chips fried with sunflower oil	3.6[b]	3.6 [a]	3.6[a]	3.9[a]

Mean scores followed by same letters along the columns are not significantly different ($P \leq 0.05$) according to Duncan Multiple range test

CONCLUSION

The characteristics of pumpkin seed oils compare well with those of common edible vegetable oils and are of good quality. It was observed that pumpkin seeds were rich in protein, crude fat, and carbohydrates and conforms very well to other edible seed oils. The observations in this study suggest that pumpkin seed oil has good keeping quality if processed under optimal conditions and packed in air tight containers. The results of sensory evaluation suggest that the oil can be used for frying purposes just like other vegetable oils. Pumpkin seed is a potential vegetable oil source and promotion is needed to make full utilization of the seeds for oil production at large scale. Farmers in Tanzania consume the flesh of pumpkin only hence there is a need to sensitize them on the nutritional and medicinal benefits of pumpkin seeds and oil. Utilization of pumpkin seed oil has been reported to delay or prevent the development of metastasis in breast cancer patients. In men, pumpkin seed relieves the urinary difficulties caused by an enlarged prostate or prostate cancer obstructing the exit to the bladder. Pumpkin seed oil is also known to prevent and alleviate bladder problems in men and women, and the seeds exhibit both antioxidant and anti-inflammatory properties. Also pumpkin seed oil is a delicious alternative to butter, and can be drizzled over salads, vegetables, grain dishes, or many other raw or cooked foods.

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