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Physicochemical Characteristics, Fatty Acid Composition, and Lipoxygenase Activity of Crude Pumpkin and Melon Seed Oils

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Physicochemical characteristics and fatty acid composition of crude oil and lipoxygenase activity of six varieties of pumpkin and melon seeds were investigated. Data obtained for the iodine value, saponification number, and acid value compare well with those of other edible oils. The major fatty acid in total lipid was 18:2 ($n = 6$), representing 68.7% for *Citrullus lanatus* (Chinese), 65% for *C. colocynthis*, 63.7% for *C. lanatus* (Iranian), 62% for *C. lanatus* (Egyptian), 53% for *Cucurbita moschata*, and 43% for *Cucurbita pepo*. Lipoxygenase activities varied among seeds. The residual enzyme activities after roasting were different among the six varieties and were in the range of 0−60% of the original activity.

Keywords: *Pumpkin; melon; lipoxygenase; physicochemical characteristics*

INTRODUCTION

Many pumpkin (*Cucurbita* sp.) and melon (*Citrullus* sp.) seeds are utilized directly for human consumption in Middle Eastern and Arabian countries. However, fluted pumpkin (*Telfairio occidentalis*), a tropical cucuribit, is grown in Nigeria for its oil-bearing seeds. The seeds are sometimes fermented to yield a product locally known as ogiri, which is used as an ingredient in a variety of local foods in Nigeria (Giami and Bekebain, 1992). May Cucurbitaceae seeds are rich in oil and protein. Although none of these oils has been utilized on an industrial scale, many are used as cooking oil in some countries in Africa and the Middle East (Curtis, 1948; Girgis and Said, 1968; Tandon and Hasan, 1977; El-Mageoli et al., 1979; Sawaya et al., 1983). Melon seeds are utilized for oil production, especially in Nigeria (Girgis and Said, 1968).

Many studies have indicated that lipoxygenase enzyme is responsible to a large extent for the initiations of undesirable flavors. Williams et al. (1986) reported that lipoxygenase rather than peroxidase is the primary enzyme in development of off-flavor in English green peas and was more heat sensitive than peroxidase. Interest in lipoxygenase is related to its action on endogenous unsaturated fatty acids resulting in the production of hydroperoxides. These hydroperoxides contribute to the formation of many aldehydes and alcohols which are responsible for the undesirable flavors which occur during storage or processing (Sessa, 1979). However, due to the differences between species and varieties of *Cucurbita* and *Citrullus* which are grown in different areas of the world, the present study was undertaken to determine the physicochemical characteristics and fatty acid composition of the crude oil as well as lipoxygenase activities before and after roasting of pumpkin and melon seeds in Saudi Arabia retail market.

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Table 1. Chemical Composition[a] of Different Varieties of Pumpkin and Melon Seeds

sample	moisture (%)	protein (%)	fat (%)	fiber (%)	ash (%)	carbohydrate (%)
C. lanatus (Egyptian)	2.61	40.5	24.0	6.5	3.0	23.4
C. lanatus (Iranian)	3.14	24.5	20.0	5.25	2.0	45.10
C. lanatus (Chinese)	3.24	39.0	21.0	2.5	1.85	32.40
C. colocynthis	3.0	29.0	50.0	8.45	3.42	6.13
Cu. moschata	3.21	24.0	43.0	6.0	1.22	23.0
Cu. pepo	3.37	26.5	37.0	3.0	1.27	28.86

[a] Means of duplicate analyses.

MATERIALS AND METHODS

Six different varieties were investigated in this study, Baladi Egyptian watermelon (*Citrullus lanatus*), Sudanese watermelon (*C. lanatus*), Iranian watermelon (*C. lanatus*), Chinese watermelon (*C. lanatus*), Egyptian pumpkin (*Cucurbita moschata*), and Iranian pumpkin (*Cu. pepo*). Raw samples were purchased from a retail market in Riyadh, Saudi Arabia, and each was divided into two groups; one was used as a raw sample, and the other was roasted on a hot plate.

The seeds were shelled by cracking with a small iron rod and then manual splitting them to remove the kernels. The kernels were packed in polyethylene bags and stored at −20 °C until used.

Proximate Analysis. Moisture, crude protein (N × 6.25), ash, and crude fat were determined according to the AOAC (1990) Methods 925.08, 904.13, 920.39, and 923.03, respectively. Carbohydrate contents were determined by difference [100 − (protein + crude fat + ash + crude fiber)]. All analyses were carried out duplicate.

Extraction and Analysis of Lipids. Five grams of kernels were ground with mortar and lipids were extracted with chloroform/methanol 2:1 (Folch, 1957). Chemical analysis of crude oils included refractive index, specific gravity, acid value, free fatty acid (FFA), saponification number, iodine value, and unsaponifiable matter. All determinations were according to the methods of IUPAC (1979).

Fatty Acid Analysis. The fatty acid analyses were determined by gas chromatography (GC) according to the procedure described by Metcalfe et al. (1966). Fatty acid methyl esters were identified on a Shimadzu gas chromatograph (GC 14A) with flame ionization detector at 250 °C. The hydrogen, air,

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Table 2. Physicochemical Characteristics[a] of Crude Pumpkin and Melon Seed Oils

sample	refractive index (30 °C)	specific gravity (60 °C)	acid value[b]	free fatty acid[c] (%)	saponification number	iodine value	unsaponifiable matters (%)
C. lanatus (Egyptian)	1.4723	0.9235	2.33	1.16	200.0	114.0	0.82
C. lanatus (Iranian)	1.4730	0.9283	4.3	2.15	218.0	110.0	0.51
C. lanatus (Chinese)	1.4725	0.9268	14.9	7.50	203.0	128.0	0.56
C. colocynthis	1.4727	0.9288	1.2	0.60	216.0	114.0	0.63
Cu. moschata	1.4717	0.9276	2.0	1.0	214.0	113.5	0.62
Cu. pepo	1.4710	0.9280	6.5	3.3	215.0	111.5	0.85

[a] Means of duplicate analyses. [b] As mg of KOH/g of sample. [c] As oleic acid.

Table 3. Fatty Acid Composition (Percent) of Crude Pumpkin and Melon Seed Oils

	14:0	16:0	16:1	17:0	18:0	18:1	18:2	18:3	20:0	22:1	SAT	MUFA[b]	PUFA[c]
C. lanatus (Egyptian)	tr[a]	11.91	0.24	0.2	9.2	15.4	62.4	0.1	0.1	0.1	21.3	15.74	62.5
C. lanatus (Iranian)	tr	11.0	tr	tr	8.0	17.8	63.7	0.11	tr	0.1	19.0	17.0	63.8
C. lanatus (Chinese)	tr	10.4	0.21	tr	7.6	12.5	68.5	0.13	tr	0.12	18.0	12.7	68.6
C. colocynthis	tr	12.0	tr	tr	11.6	10.7	65.1	tr	0.14	0.11	23.74	10.8	65.1
Cu. moschata	0.16	13.1	0.3	0.28	6.0	26.2	53.2	0.12	0.17	0.14	19.71	26.64	53.33
Cu. pepo	0.13	11.8	0.37	0.2	6.3	34.9	43.1	0.9	0.7	0.8	19.13	36.1	44.0

[a] tr, trace less than 0.1%. [b] MUFA, monounsaturated fatty acids. [c] PUFA, polyunsaturated fatty acid..

and nitrogen flow rates were 30, 250, and 20 mL/min, respectively. A 1 μL sample was injected on $^1/_8$ in. × 6 in. column packed with 10% ep 2330 on Chromosorb 100/120 mesh size. The injection temperature was 240 °C, and the column temperature was 130−200 °C. Comparison between the peaks from the samples and those of standards, run on the same column under the same conditions, was the means of identification.

Lipoxygenase Assay. Crude lipoxygenase was extracted from 0.5 g of powdered, defatted seeds with 10 mL of 0.2 M sodium phosphate buffer (pH 6.5) for 20 min (Sosulski and Gadan, 1988). Insoluble material was separated by centrifugation for 15 min at 10 000 rpm, and the supernatant was made up to 10 mL. Linoleic acid (20 mL) was mixed with an equal volume of Tween 20, and 8 mL of H_2O and 2 mL of 0.1 N NaOH were added under shaking. Volume was completed to 50 mL with water. The reaction mixture consisting of 2.5 mL of phosphate buffer (pH 6.5), 0.5 mL of substrate, and 10 mL of enzyme was added to a 1 cm diameter cell. The increase in absorption was measured at 234 nm over a 5 min period using an LKB spectrophotometer.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of the different varieties of pumpkin and melon seeds. The highest fat concentration (50%) was found in *C. colocynthis*, while the lowest (20%) was found in *C. lanatus* (Iranian), which has the highest carbohydrate content. The protein content range from 40.5% in *C. lanatus* (Egyptian) to 24% for C*u. moschata*.

Some of the chemical and physical properties of the crude oils are presented in Table 2. The specific gravity values compared well with the 0.915 value reported by Kamel et al. (1985) and Badlfu (1991). The oils had relatively high iodine values, thus reflecting a high degree of unsaturation. Saponification numbers were relatively higher than those reported in the literature for cottonseed oil (189−198) but were relatively lower than those for coconut oil (248−265) (Codex Alimentarius Commission, 1982). The highest acid value and free fatty acids were found in *C. lanatus* seed oil. This indicates the high degree of lipolysis due to enzymatic activity. Virgin palm oil may contain as high as 100 mg of KOH/g of oil (Codex Alimentarius Commission, 1982). Oils were low in unsaponifable matter, and average values for refractive index and free fatty acids were comparable to those reported by Lazos (1986), Badlfu (1991), and Kamel et al. 1982).

Table 4. Effects of Roasting on Lipoxygenase Activity (Units per Gram) in Pumpkin and Melon Seeds

	raw seeds	roasted seeds	residual activity (%)
C. lanatus (Egyptian)	64000	16000	25
C. lanatus (Iranian)	12400	4800	38
C. lanatus (Chinese)	25650	14000	54
C. colocynthis	16150	4150	26
Cu. moschata	11000		0
Cu. pepo	6000	3600	60

Table 3 shows the fatty acid compositions of crude melon and pumpkin seed oils. The predominant fatty acid was 18:2*n*−6 representing 68.5% for *C. lanatus* (Chinese), 65% for *C. colocynthis*, 63.7% for *C. lanatus* (Iranian), 62% for *C. lanatus* (Egyptian), 53% for *Cu. moschata*, and 43% for *Cu. pepo*. There were wide variations among the contents of 16:0, 18:0, 18:1*n*−9, and 18:2*n*−6 among different varieties. The total saturated, monoene, and polyunsaturated fatty acid (PUFA) contents were also different. Such differences may be due to various factors including harvest time, variety, source, drying conditions, seasonal variation, soil and storage condition, and level of maturity. The levels of total PUFA were 68.6%, 65.5%, 63.8%, 62.5%, 53.3%, and 44% for *C. lanatus* (Chinese), *C. colocynthis*, *C. lanatus* (Iranian), *C. lanatus* (Egyptian), *Cu. moschata*, and *Cu. pepo*, respectively. The fatty acid profile of the melon and pumpkin seed oils resembled those reported by others; melon and pumpkin seed oils contained low amounts (18−23.7%) of totally saturated fatty acids, and this could be an advantage since a diet low in saturated fat can benefit patients with cardiovascular disease.

Lipoxygenase activity in seed extracts varied considerably among the six varieties (Table 4). *C. lanatus* (Egyptian) has the highest lipoxygenase activity, while the lowest activity was found in *Cu. pepo*. The residual enzyme activities after the six varieties were roasted were in the range of 0−60% of the original activity. This indicates the variable heat stability of lipoxygenase among seeds. Lipoxygenase is known to have low heat resistance. William et al. (1986) found that heating English green peas and asparagus for 10 min at 60 °C resulted in 30% and 71% residual lipoxygenase activity, respectively.

The results of this investigation showed that seed oils contain large amounts of PUFA and monoenes and low amounts of saturated fatty acids. This result represents

the effects of roasting on lipoxygenase activity in seed extracts which indicate the variable heat stability among seeds that helps the seed roaster to treat seed at different temperatures.

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