STORAGE STABILITY OF RAM PRESS EXTRACTED SEMI-REFINED SUNFLOWER OIL

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Abstract

On-farm processing of oilseeds using the manually operated ram press has spread to many rural areas in Kenya in recent years. The products of the processing operation are semi-refined edible vegetable oil and protein cake. This study was undertaken to determine storage stability of the oil. Sunflower oil was extracted using the ram press and stored in glass and plastic bottles which were left either open or closed, were either fully filled or with a headspace for a period of up to 6 months. Peroxide values and acid values were measured during the storage period. Potato chips were deep fried in the different oils and subjected to pair and triangle comparison tests to determine differences in texture and taste. After six months of storage, the peroxide value of the oils had not exceeded 20 milli-equivalent peroxide oxygen/g. Acid values rose slightly with the maximum rise being from 0.52 to 0.82 milligrams KOH/g. There was no significant preference for potato chips fried in Saladin oil, ram press oil or rancid sunflower oil at the 0.05 level. For long storage life, oil from on-farm processing should be stored in colored bottles, fully filled and tightly closed.

Key words: sunflower oil; semi-refined; ram press; storage stability, hydrolytic rancidity, oxidative rancidity

INTRODUCTION

The objective of introducing the manual ram press in rural areas of Kenya was to promote oilseed production and utilization of vegetable oils. On-farm processing adds value to the oilseed crop and in addition, the farmer is able to utilize the products of the processing operation, oil and protein cake directly at home (Kamau, 1994). Previously, farmers sold the oilseed crop to commercial processors and had no direct use of the crop. On-farm oil extraction is carried out using the ram press, a manually operated device that applies mechanical force to the seed, crushing it and squeezing the oil out. After extraction, the oil is filtered through a canvas cloth mounted on a gravity flow filtration device. No further refining processes are carried out and the oil is used in that semi-refined form (Kinaga, 1997). Industrial oil refining processes are aimed at removing non-triglycerols such as complex lipids, monoglycerides, diglycerides, gums, fatty acids and products of auto-oxidation. These substances pose no direct health hazard to the consumer, but might affect the flavor and appearance of the oil, hence affecting consumer acceptability (Nawar, 1996; Weiss, 1972). Additionally, the refining process is likely to remove some beneficial phytosterols from the oil (Nanua et al., 2002).

Vegetable oils are rich in polyunsaturated fatty acids which are prone to oxidation resulting in peroxides and other compounds that give the oil an objectionable odor (Passmore and Eastwood, 1996; Nawar, 1996). Two main changes, oxidative rancidity and hydrolytic rancidity affect the keeping quality of oils. Oxidative rancidity is caused by the oxidation of the double bonds of the fatty acids while hydrolytic rancidity is caused by the removal of fatty acids from the glycerol molecule. Hydrolytic rancidity is encouraged by the presence of moisture and lipolytic enzymes in the oil. Since the oil is not heated, it is likely that lipases that can lead to hydrolytic rancidity are present (Weiss, 1972).

Reports on various aspects of the on-farm processing of oilseeds generally give only a passing mention of the keeping quality and other characteristics of the semi-refined oil (Kamau, 1994; Nanua, 1996; Kenya Bureau of Standards (KBS), 1982). Data in literature mainly covers the shelf life and quality of fully refined vegetable oils (Nawar, 1996; Passmore and Eastwood, 1996). Although the ram press is a manual device, its rate of oil output, at about 10-15 liters per day, is at commercial level in rural areas of Kenya (Nanua, 1996). The oil is sold to neighbors, boarding schools, hotels and other commercial outlets and therefore, its keeping quality under the prevailing storage conditions is of importance to both the producers and consumers. Containers available for storing the oil in rural areas are used plastic and glass containers, and this compounds the problem of the keeping quality of the oil. This study was undertaken to investigate the storage stability of the semi-refined vegetable oil under the prevailing conditions in rural areas of Kenya.

MATERIALS AND METHODS

Vegetable oil was extracted from sunflower seed using the ram press and the oil filtered with a canvas cloth mounted on a gravity flow filter device. Samples of the oil were subjected to four treatments: Stored in closed clear glass bottles; stored in open opaque plastic bottles; stored in closed opaque plastic bottles; and heated to 90°C and stored in closed opaque plastic bottles. All the samples were stored in a wooden rack at room temperature averaging about 23°C daily for 4 months. During the storage period, samples were taken from the oils and analyzed for peroxide value (PV) and acid value (AC) following the methods described by the Kenya Bureau of Standards (1982). These tests were designed to determine the influence of light, air and heat on the keeping quality of the oil.

From the results of the preliminary storage stability tests described above, it was found necessary to carry out further experiments on the influence of oxidative rancidity on oil quality during storage. The oils used in these experiments were extracted from sesame, groundnut and sunflower seeds using the ram press then filtered. Samples of the oils were stored in colored glass bottles in two sets. In the first set, the bottles were filled completely and closed while in the second set a headspace of about 20% was left. The samples were stored at room temperature and analyzed for PV for a period of six months.

Organoleptic tests were carried out to compare the ram press extracted oil with two brands of commercial oil, Saladin (manufactured by Arkay Industries, Eldoret, Kenya) and Elianto (manufactured by Elianto Kenya Ltd, Nakuru, Kenya), and a rancid sample of the ram press extracted oil (ORPO). The characteristics tested were color and odor of the oils and taste and texture of potato chips deep-fried in the oils. Pair comparison tests were used to compare the color while triangle and pair comparison tests were used for odor. The taste and texture of potato chips fried in the oils were subjected to triangle and pair comparison tests as described by Gridgeman (1967).

RESULTS AND DISCUSSION

The peroxide value (PV) of all samples increased with storage time but at varying degrees for the different storage treatments as illustrated in Figure 1. The oil in open opaque plastic bottles had the highest PV at 47.34 milli-equivalent (ME) of peroxide oxygen per kg fat while that stored in glass bottles had the lowest at 21.41 ME after four months of storage. The high PV for oil stored in open bottles was probably due to the reaction of the oil with atmospheric oxygen that is normally involved in the oxidation reactions (Nawar, 1996). Heated oil had a higher PV than unheated oil stored under similar conditions. This could be due to thermal destruction of some anti-oxidants or due to an initial acceleration of oxidative reactions during the heat treatment.

Contrary to expectations, the oil stored in transparent glass bottles had the lowest PV after storage for four months. It was expected that light would accelerate auto-oxidation hence raise PV. This indicated that the plastic bottles might have had some pro-oxidants that accelerated oil oxidation during storage. The plastic bottles were bought in the used-bottles market and therefore, could have had traces of oil in them even after cleaning. This could have triggered the auto-oxidative reactions by providing free radicals. The use of these plastic bottles was meant to simulate rural conditions where farmers use such containers. Such bottles had originally been used by commercial oil manufactures to package their oil.

The AV for all samples rose slightly during the four months of storage as shown in Table 1. The limit of hydrolytic rancidity is taken as an acid value of 0.75 milligrams KOH/g fat (Nawar, 1996; Weiss, 1972). Therefore, treatment and storage conditions did not seem to affect the rate of acid development. Under the current processing and consumption patterns in the rural

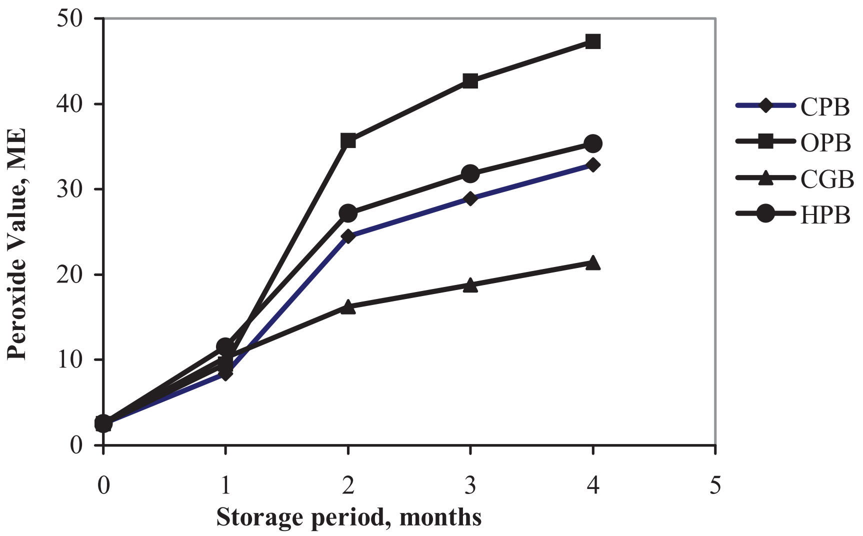

Figure 1: Variation of peroxide values with storage period
CPB = closed plastic bottles; OPB = Open plastic bottles, CGB = Clear glass bottles; HPB = Heated oil in plastic bottles

areas of Kenya, therefore, hydrolytic rancidity is not a limiting factor. It was expected that lipases were present leading to a lower AV for the heated oil but this was not the case. Table 2 shows PV of vegetable oils stored at room temperature in coloured glass bottles with and without headspace. The oil packed with headspace developed oxidative rancidity faster than the oil stored without headspace. After six months of storage, none of the samples had exceeded the limit of peroxide value of 20 ME peroxide oxygen/kg. For the fully filled bottles, oxygen was the limiting factor and it probably was also a limiting factor in the bottles with a headspace after all oxygen was used up. Comparing these results and those of the preliminary experiments showed a similar trend in the rise of the PV for closed and open bottles. However, the initial PV for the preliminary experiments was relatively higher which may have been caused by prolonged handling during filtration and initial experimental set up. The high initial PV also caused the resulting high values after 4 months of storage. After storage for three months, the peroxide values of the test samples stored without headspace were well within peroxide values of vegetable oils randomly purchased from local supermarkets as shown in Table 3.

Table 1: Acid values of sunflower oil stored under different conditions for a period of four months

Treatment	Acid values* during storage for four months				
	initial	1	2	3	4
Closed Plastic bottles (opaque)	0.56	0.62	0.75	0.79	0.85
Open plastic bottles (opaque)	0.56	0.62	0.68	0.74	0.81
Clear glass bottles	0.56	0.62	0.68	0.75	0.82
Heated oil in plastic bottles (opaque)	0.56	0.62	0.67	0.74	0.81

*Acid values in milligrams KOH/g

Table 2: Peroxide values during storage for six months

Type of oil	Treatment	Peroxide Value (ME peroxide oxygen/kg oil)						
		initial	1*	2	3	4	5	6
Sesame	Headspace	0.52	2.26	3.23	3.16	4.95	7.67	13.15
	Full	0.52	1.48	1.94	2.13	2.86	3.00	3.21
Groundnut	Headspace	0.82	6.39	12.24	15.55	15.78	16.49	16.77
	Full	0.82	2.51	2.58	3.48	3.74	4.31	4.81
Sunflower	Headspace	0.75	6.66	10.27	12.71	13.76	14.46	15.25
	Full	0.75	2.92	3.47	3.95	4.01	4.95	5.66

*Months

Table 3: Peroxide values of commercial oils

	Elianto (corn oil)	Saladin (sunflower)	Ufuta* (sesame)	Golden fry* (palm oil)
Sample 1	0.96	4.74	1.73	1.42
Sample 2	0.53	3.21	2.81	2.65
Mean	0.75	3.98	2.27	2.02

*Manufactured by Ufuta Ltd, Mombasa, Kenya

Results of the organoleptic tests for color, smell, taste and texture of chips fried in fresh ram press oil (RPO), old ram press oil (ORPO), Saladin oil and Elianto oil are shown in Tables 4 and 5. In terms of color and appearance, RPO was preferred over both Saladin and Elianto oils. The panelists described Saladin oil as too dark while Elianto oil, which is partially bleached, was described as looking dilute or watery. These results implied that it is not necessary to bleach sunflower oil, as its native color, which is pale yellow, is acceptable to consumers. In addition, bleaching removes carotenoids that have vitamin A activity (Nawar, 1996; Weiss, 1972). In triangle tests for smell, the odd sample was positively identified at 0.05 significant levels. In pair comparison tests, preference for RPO was significant over ORPO at 0.05 levels. Therefore, after four months of storage, the oil had developed detectable odor. However, there was no significant difference between RPO, Saladin and Elianto oils. From Table 4, the panelists were not able to identify chips fried in fresh oil from those fried in rancid sunflower oil. This was probably because the rancidity did not persist in the chips. However, during the frying process, the rancid oil gave off objectionable odor. Although it was possible to identify the chips fried in un-deodorized sunflower oil from those fried in deodorized oil, the flavor did not seem to affect its acceptability.

Table 4: Pair comparison tests

Attribute	N	Preference for
Color:		
RPO and Elianto	23	19** (RPO)
RPO and Saladin	11	10** (RPO)
Smell:		
RPO and ORPO	13	11** (RPO)
RPO and Saladin	11	9 (ORPO)
RPO and Elianto	11	10 (RPO)
Fried Chips:		
RPO and ORPO	11	7 RPO
Saladin and RPO	11	7 RPO
Saladin and ORPO	11	8 ORPO

N – Number of respondents, RPO = Ram press extracted sunflower oil, ORPO = Old ram press extracted sunflower oil
** = 0.01 significance level, * = 0.05 significance level

Table 5: Triangle comparison tests

Attribute	N	Correct Answers
Smell: RPO and ORPO	11	9*
Chips fried in:		
RPO and ORPO	11	6*
ORPO and Saladin	11	8*
RPO and Saladin	12	10**

N – Number of respondents, RPO = Ram press extracted sunflower oil, ORPO = Old ram press extracted sunflower oil
** = 0.01 significance level, * = 0.05 significance level

CONCLUSION

Vegetable oil obtained from on-farm processing with the ram press should be stored in colored bottles, full filled and tightly closed. The storage period should not exceed six months. The oil need not be bleached or deodorized as its native color and odor was acceptable to consumers. Under the current processing and consumption patterns in the rural areas of Kenya, hydrolytic rancidity is not a limiting factor.

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