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*Full Length Research Paper*

# Quality evaluation of sunflower and groundnut oil produced by two cooperatives under the one village one product programme in central Malawi

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**Physicochemical properties of cooking oil as quality parameters are very important in predicting the appropriate uses of cooking oil. These properties have been known to be affected by several factors such as processing and storage conditions. In this study, quality evaluation was carried out on sunflower and groundnut cooking oils obtained from two cooperatives under the Malawi government initiated programme called One Village One Product. Furthermore, an evaluation was also carried on the cooperative's knowledge on food processing related standards as well as the extent of compliance of the processing premises to the stipulated standards. Results showed with exception of moisture content that values for peroxide value, saponification value and iodine value were within the ranges specified by the local and codex based standards. The cooperatives were also found to have adequate knowledge on food processing related standards and met most of the requirements with respect to the processing premises. However, little non compliance was also identified with respect to quality and processing premises compliance. The study concludes that the quality of sunflower and groundnut oil was of acceptable quality and safe to consumers.**

**Key words:** Sunflower oil, groundnut oil, peroxide value, saponification value, iodine value.

## INTRODUCTION

Edible vegetable oils are foodstuffs which are composed primarily of glycerides of fatty acids being obtained only from vegetable sources which may also contain small amounts of other lipids such as phosphatides, of unsaponifiable constituents and of free fatty acids naturally present in the fat or oil (FAO/WHO, 2001). Vegetable oils are important in human nutrition, providing energy and essential fatty acids and facilitating absorption of fat-soluble vitamins (PROTA Foundation, 2008).

The quality of the oil is very important and the extent of the oil quality can determine its desirable use. Oil quality is defined as physical and chemical properties of fats or oils that are necessary for any specific purpose as stated in a product specification or certificate of analysis. A number of factors have been reported to affect oil quality

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and include pre-processed factors such as growing season, soil fertility, post harvest storage conditions such as temperature and post process factors such as heat-thermal degradation and air contact (Turner, 2010). A number of authors have similarly highlighted other factors affecting quality of oil. The quality of vegetable oil has also been reported to be dictated by several physical and chemical parameters that are dependent on the source of oil, processing and storage conditions (Shahidi, 2005). Furthermore, some of the parameters used to evaluate the quality of the oils according to Chabiri et al. (2009) has been outlined and include moisture content, smoke point, saponification value, acid value, iodine value and peroxide value among other parameters.

Over the years in most developing countries, communities have realized the importance of adding value to their locally produced food resources. This realization has further been enhanced by a number of programmes involving communities implemented by various stakeholders including government initiated programmes. In Malawi, since the launch of a government initiated programme called One Village One Product in 2003, there have been a number of cooperatives under the programme who are involved in value addition. The One Village One Product (OVOP) programme is a community centered and demand driven regional economic development approach initiated by Oita prefecture in Japan in 1970s. The programme which was officially launched in Malawi in 2003 aims at generating incomes and wealth for the Malawian society by community mobilization to produce value added goods and services that are marketable in order to reduce wealth disparities(OVOP national secretariat, 2013). Although the emergence of small scale processors in any developing country such as Malawi is a welcome development, it is common knowledge that small scale food processing is usually constrained by a number of problems such as poor understanding of quality requirements, inadequate hygiene, inadequate processing skills, limited knowledge in both local and international food standards and many more others. These food processing related constraints affecting the small scale processors ultimately in most instances results in products with low quality whose safety cannot also be guaranteed. These problems are not confined to small scale processors only and in a study involving quality evaluation of 35 commercially available cooking oil brands sold in Pakistan market, it was found out that quality parameters such as free fatty acids, peroxide value, smell, weight and rancidity value significantly deviated from standards set by the Pakistan Standard Quality Control and Authority (Mehmood et al., 2012). It is clearly evident from a number of reported findings that most problems affecting small scale food processors are multi-faceted. Constraints faced by small scale oil palm fruit processors in Ghana were found to be multi-faceted and multi-scale and it was concluded that a cross-disciplinary research approach was needed to effectively address these complex issues and search for integrative solutions that are well embedded in the current local processing practices (Amponsah et al., 2012). Oxidation of oils is a major contributing factor to the reduction of quality and a number of authors have previously reported factors such as processing procedures, temperature, light and oxygen as the main causes of oxidation in edible oils (Jung et al., 1989; Shahidi and Spurvey, 1996; Yen and Shyu, 1989). With respect to edible oils, the type of raw oil, its colour, free fatty acid content, taste and other physical and chemical properties are such other parameters that need specific attention in order to obtain the much needed quality of the finished product (Egbuna et al., 2013). However, considering that a majority of food products produced by various small scale processors are rarely tested and coupled with limited knowledge in quality assurance and food safety, the likelihood of the food products deviating from standards set by food regulating agencies is assumed to be high and therefore every effort needs to be put in place to ensure that products from small scale processors are regularly evaluated to ensure consumer’s health and safety. Information on the composition and quality characteristics of locally sourced lipids has been reported to be scarce (Babalola and Apata, 2011). The objective therefore in this current study was to evaluate the quality of sunflower and groundnut cooking oils based on selected physicochemical properties produced by two cooperatives under the One Village One Product Programme in two districts in central Malawi. The choice of the selected physicochemical properties of the oils was based on the relevance in the determination of oil quality. Furthermore, an evaluation was also carried out to determine the extent of the cooperatives knowledge in domestic food standards and compliance to relevant country’s based mandatory food standards as well as some aspects in the Codex alimentarius code of hygiene practice.

## MATERIALS AND METHODS

### Identification of the cooperatives

The two cooperatives which were involved in this study were identified through consultation with management of the One Village One Product programme which is under the Malawi Government Ministry of Trade and Industry. Two cooperatives involved in the processing of sunflower and groundnut cooking oils from Lilongwe and Mchinji districts in central Malawi were purposefully chosen. Considerations on the choice were based on cooperatives performance with respect to product quality and marketing competence, products produced and proximity to the main study area which is Lilongwe University of Agriculture and Natural Resources where the analysis of the samples were carried out. Verbal consent to use the information and data obtained from the two cooperatives in this study was given by both the One Village One Product Programme secretariat and the two cooperatives. However, consent to use the names of the cooperatives was not given and in this respect, the cooperative from Lilongwe district would be denoted as cooperative A and the cooperative from Mchinji district would be denoted as cooperative B in this study.

### Focus group discussions and auditing of the processing premises

A comprehensive checklist covering various aspects from the Codex Alimentarius General Principles of Food Hygiene (CAC/RCP 1-1969) and Malawi Standard 21: Food and Food Processing units-Code of hygienic conditions was compiled and used for both focus group discussions and auditing of the processing premises to evaluate the cooperative's knowledge and compliance to the stipulated mandatory standards. Furthermore, the checklist also included some questions on good manufacturing practices. Some of the leading questions in the checklist covered areas such as hygienic requirements in production areas, design and facilities in the establishment, personal hygiene and health requirements, sanitation, raw materials transportation and storage and hygienic processing requirements. A group of 10 to 15 members of the two cooperatives involved in the processing of the cooking oils participated in the focus group discussions.

### Sample collection

Samples of recently produced sunflower and groundnut cooking oils were randomly selected from the two cooperatives. A total of 3 to 4 bottles each 250 ml from the two cooking oils were collected. The Lilongwe based cooperative provided the two types of the cooking oils while the Mchinji based cooperative provided only the sunflower cooking since it was only producing sunflower cooking oil.

### Physicochemical analysis

The physicochemical analysis of the samples was carried out within a week after the samples were collected from the two cooperatives. Moisture content, smoke point, iodine value, peroxide value and saponification number were all determined by the procedure prescribed in AOAC (2002).

### Statistical analysis

Data obtained from the physicochemical analysis of the sunflower and groundnut cooking oils was analysed using Gen-Stat (version 14.0). Responses obtained from the focus group discussions and observations from auditing of the processing premises were manually summarized and compared with the stipulated requirements in local mandatory food standards and Codex Alimentarius General Principles of Food Hygiene (CAC/RCP 1-1969).

## RESULTS AND DISCUSSION

### Cooperative's knowledge on food processing standards and processing premise's extent of compliance to local and codex alimentarius codes of hygiene practices

Responses obtained from the focus group discussions were manually summarized and compared with the specifications stipulated in both the local food standards (MS 21) and the Codex Alimentarius General Principles of Food Hygiene (CAC/RCP 1-1969) in order to draw meaningful conclusions on the cooperative's extent of knowledge. Similarly, observations made from the inspection or auditing of the processing premises were also accordingly compared to the stipulated specifications of the standards. A summary of the responses showed that both cooperative A and B had considerable knowledge of the local food standards regarding food processing requirements. This was evidenced by for example the cooperative's ability to keep records of different activities or operations at the factory including guidelines for choice of raw materials and transportation, availability of information about the processes which were well defined and controlled and availability of health records for the workers. Furthermore, there were written down procedures for oil processing and instructions for visitors. The members from the two cooperatives were also able to correctly respond to the questions pertaining to reasons behind undertaking some steps in the processing of oils and other issues which were general in nature. However, there other noted knowledge gaps as evidenced by the lack of HACCP system in place which is now a mandatory requirement, inability to explain the significance of the batch numbers on their products and having no end-product specifications. The food processing sector especially for the small scale processors is known to be constrained by inadequate processing methods, lack of access to equipment and packaging, weak linkages with producers and poor marketing skills (Byanyima, 2004). It was revealed during the focus group discussions that these two cooperatives are under the Malawi Bureau of Standards certification scheme where they are regularly monitored and this explained why they had a better understanding of the local mandatory food standards. Other authors have reported that small holders as compared to large scale farmers face difficulties in complying with standards due to a range of constraints such as access to information, capital, services and availability of labour (Asfaw, 2008). A summary of the observations from inspection of the processing premises of the two cooperatives showed that they have satisfied the majority of the requirements stipulated in the local food standards (MS 21) as well as those in Codex Alimentarius General Principles of Food Hygiene. The audit found out that the two cooperatives had met satisfactorily the following requirements: Buildings and facilities of permanent nature, availability of toilets, availability of changing rooms and hand washing facilities, availability of uniforms for the workers, insect proof window screens, waste disposal facilities, hygiene control programme, water-proof and washable walls and the floors were clean and walls smooth. It was noted that most of the specifications in the food standards were not applicable for a cooking oil processing facility and therefore those aspects were accordingly skipped during the inspection of the facilities. Despite satisfying a majority of the requirements, it was noted that there were some few notable non compliances. The non compliances included

**Table 1.** Physicochemical properties of sunflower cooking oil.

| Property | Cooperative A | Cooperative B |
|---|---|---|
| Peroxide value (meq/Kg) | 3.32 ± 1.15[a] | 3.30 ± 1.15[a] |
| Smoke Point ($^0$C) | 196.60 ± 0.17[a] | 196.50 ± 0.57[a] |
| Saponification_value (mg/KOH/g) | 188.90 ± 2.85[a] | 189.00 ± 1.91[a] |
| Moisture content (%) | 0.20 ± 0.10[a] | 0.27 ± 0.12[a] |
| Iodine value (g/100g) | 124.80 ± 3.45[a] | 125.70 ± 2.81[a] |

Means in the same row with the same superscripts are not significantly different (P<0.05).

non availability of pest control systems, non availability of a system for recalling batch of products and lack of product information and consumer awareness program. Considering the small scale status of the two cooperatives, it was concluded that these cooperatives are doing well with respect to their knowledge of food processing requirements and compliance to the relevant local standards and with the ongoing certification scheme, there is hope that they would further improve for the better and address the identified non compliances.

### Physicochemical properties of sunflower cooking oil

The results for physicochemical properties of sunflower cooking for cooperative A and cooperative B are presented in Table 1. Results from the analysis showed that all the physicochemical properties namely peroxide value, iodine number, smoke point, saponification number and moisture content were not significantly different in the two sets of the sunflower oil obtained from the two cooperatives. The value ranges for the physicochemical properties of the two sets of sunflower cooking oil from the cooperative A and B were as follows: Peroxide value ranged from 3.30-3.32 meq/kg, smoke point ranged from 196.5 to 196.6°C, saponification number ranged from 188.9 to 189.0 mg/KOH/g, iodine number ranged from 124.8 to 125.7g/100 g and moisture content ranged from 0.20 to 0.27%. When comparison was made with the values for peroxide value, saponification number and iodine number stipulated in the Codex Standard for named vegetable oils (CODEX STAN 210-1999), it was found out that the values were within the specified ranges. However, saponification and iodine number values were found to be within the specified ranges in the local standard (Table 3) while peroxide value and moisture content values were not within the stipulated ranges. The maximum permitted value of 2.5 was for refined sunflower oil and an evaluation of the refining process by two cooperatives which uses a white clean cloth meant this cannot qualify to be refined sunflower oil rather it should be categorized under cold pressed oils which the local standard did not specify. In view of the absence of the specifications in local standards for cold pressed oils for peroxide value, it can be assumed that the peroxide value was within the acceptable ranges based on the codex based specifications. Moisture content was found to be above the maximum permitted level (Table 3) and smoke point was not included in both the local and codex based standards but higher smoke points values may indicate suitability of oil for different purposes such as cooking and it has been reported that oils that have smoke points higher than 190 $^0$C are good for frying because they can be reused several times before they completely decompose (Culinary - Yours Consulting, 2011). Our results on the physicochemical properties of sunflower oil were found to differ from previous reported findings from other authors and this was not surprising as other researchers have reported that oil quality is dictated by several physical and chemical parameters that are dependent on source of oil, processing and storage conditions (Shahidi, 2005). Peroxide value, iodine value and saponification number which had value ranges of 3.30 to 3.32 meq/kg, 124.8 to 125.7 g/100 g and 188.9 to 189.0 mg/KOH/g respectively were different from values of 2.04meq/kg, 125.17g/100g and 151.33mg/KOH/g as reported by Babalola and Apata (2011). Furthermore, values for iodine and peroxide values were also different from those reported by Shastry et al. (2011) who found out that fresh sunflower oil had values of 132.0 g/100 g and 6.6 meq/kg for iodine value and peroxide value respectively and further reported that the values in reused sunflower oil increased to 145.5 g/100 g for iodine value and 17.3 meq/kg for peroxide value. The fact that the values obtained for all the physicochemical properties with the exception of peroxide value from sunflower oil from cooperative A and B were all within the ranges as stipulated in the local and codex alimentarius based standards suggest that sunflower oil produced by the two cooperatives was of acceptable standard and quality and therefore safe for the consumers. However, it is suggested that the two cooperatives should identify the reasons contributing to the higher moisture content so that all the physicochemical properties are within the acceptable ranges.

### Physicochemical properties of groundnut oil

Results on physicochemical properties of groundnut cooking oil for cooperative A which is based in Lilongwe

**Table 3.** Physicochemical properties values as specified in Codex standard for named vegetable oils (CODEX STAN 210-1999), MBS 77:1988, groundnut oil-specification and MBS 78: 1988, refined sunflower oil specification.

| Standard | Pv | Iv | Sn | Mc | Sp |
|---|---|---|---|---|---|
| **Codex Stan 210-1999** | | | | | |
| Sunflower oil | up to 10 | 118-141 | 188-194 | - | - |
| Groundnut oil | up to 10 | 86-107 | 187-196 | - | - |
| **MBS 77-Groundnut oil-specification** | | | | | |
| | up to 10 | 80-106 | 187-196 | 0.1 | - |
| **MBS 78- Refined sunflower oil specification** | | | | | |
| | up to 2.5 | 125-136 | 188-195 | 0.1 | - |

Pv=peroxide value (meq/kg), Iv=iodine value (g/100 g), Sn=saponification number (mgKOH/g), Mc=moisture content (%, m/m), Sp=smoke point ($^{o}$C), - = value not given.

**Table 2.** Physicochemical properties of groundnut oil for cooperative A.

| Property | Mean value |
|---|---|
| Peroxide value (Meq/kg) | 9.89 ± 0.16 |
| Smoke point (°C) | 226.10 ± 0.40 |
| Saponification_Value (mg/KOH/g) | 189.40 ± 0.93 |
| Moisture content (%) | 0.20 ± 0.10 |
| Iodine value (g/100g) | 91.46 ± 0.67 |

district in central Malawi are presented in Table 2. The Mchinji district based cooperative was not producing groundnut cooking oil and therefore the presented results are for cooperative A only. The obtained values for the different physicochemical properties just like in sunflower oil were different with those reported by other authors which could be attributed to a number of factors such as storage conditions and furthermore it has been reported that cooking oils can be spoiled by air and light and it is recommended that the packaging of any such products should exclude light and air (Fellows and Axtell, 2002). The peroxide value, iodine and saponification values obtained in this study for the groundnut oil (Table 2) were different to those reported by Babalola and Apata (2011) who reported 1.54 meq/kg, 13.27 g/g and 209.0 mgKOH/g for peroxide value, iodine value and saponification value, respectively. It was further observed that peroxide value (Table 2) was close to the maximum permitted levels as specified in both Codex alimentarius based and local standards (Table 3) which implied that there might be other post processing related factors contributing to the higher values as revealed in findings of Manral et al. (2008) who reported that peroxide value of sunflower oil used in frying of fish evaluated at 2 h interval for 14 h increased from 0.1 to 24.88 meq/kg while the iodine value decreased from 126.44 to 117.42 g/100 g. However, with the exception of moisture content, the values obtained for peroxide value, saponification number and iodine value were within the ranges as stipulated in the local standard covering groundnut oil (Table 3). Differences in the physicochemical properties of the groundnut oil has also been reported to be due to differences in cultivar type and our results which reported iodine value of 91.46 g/100 g was found to fall in the iodine value ranges of 85.77 to 98.43% for 20 groundnut varieties grown in Ghana (Asibuo et al., 2008). The moisture content was found to be outside the specified range suggesting that there is for the cooperative to work on the manufacturing process to address this non compliance as well as the peroxide value which needs to be significantly reduced.

## Conclusions

In this study, the physicochemical properties of sunflower and groundnut oil obtained from the two cooperatives under the Malawi government initiated One Village One Product Programme were investigated. Furthermore, an evaluation of the cooperative's knowledge on food processing related standards as well as extent of processing premises compliance to stipulated standards requirements was also carried. Findings revealed that the peroxide value, saponification and iodine values were within the ranges as specified in the local standard covering edible oils and Codex standard for named vegetable oils. This demonstrated that the cooking oils produced by the two cooperatives satisfactorily met the required quality standards and therefore safe to consumers. The study findings further revealed that the two cooperatives have considerable knowledge in food processing standards and the processing premises met a majority of the requirements stipulated in the standards. However, the moisture content for the sunflower and groundnut oil from the two cooperatives was higher than the maximum permitted levels and some noted non compliances with respect to the processing premises included the availability of pest control system, HACCP system and a recall mechanism. Considering their small scale status, it can be concluded that quality of the sunflower and groundnut cooking oil produced by the two cooperatives is of acceptable standard and safe to consumers and that the cooperatives had better understanding of appropriate food standards and needs to be encouraged to continue complying to the requirements as stipulated in the standards with respect to oil quality and processing premises requirements.

## Conflict of Interest

The authors have not declared any conflict of interest.

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