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Quality of honey processed and stored by honey processors and traders in the mountains of northern Kenya

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Abstract

A study was conducted in the mountains (Nyiru, Ndoto and Marsabit) of northern Kenya to determine the quality of honey processed and stored by honey processors and traders. Twelve processed and stored honey samples were randomly collected from processing groups and honey traders in three honey markets. The samples were analyzed for moisture content, total reducing sugars, apparent sucrose, acidity and Hydroxymethylfurfural (HMF) by applying the Harmonized Methods of the International Honey Commission or the Association of Official Analytical Chemists. The mean moisture content, reducing sugars, apparent sucrose, acidity and HMF values of 18.0%, 69.5%, 2.8%, 26.1meq/kg and 3.6 mg/kg, respectively met the Codex Alimentarius and Kenya national quality standards. However, with storage the acidity and HMF increased while the moisture content of honey decreased. In conclusion, honey processed in northern Kenya using simple straining methods and stored up to fourteen months was of acceptable quality and qualify for sale in urban and regional markets.

Key words: *Chemical composition, honey, mountains, processed, storage*

Introduction

Food quality is one of the most important factors determining the consumer's perception, acceptance, attraction and purchase of product (Szefer and Nriagu, 2007). The demand for quality as a driver of markets

and production is appearing a global phenomenon (Reardon et al., 2001). Hive products such as honey with a ready local and global market, demand for product quality maintenance. Processing, storage and packaging of honey need special attention in order to secure the quality of the product and hence the sales prospects (GTZ, 1999).

In the arid and semi-arid lands of Kenya, value addition of livestock products is a key development strategy for diversifying sources of income for rural households (GOK, 2010). In the mountains of northern Kenya (Nyiru, Ndoto, Kulal and Marsabit), honey is a major hive product processed for market. Studies conducted in northern Kenya, has shown that honey processors obtained 100% profit by processing crude honey (Lengarite et al., 2005). The processors, who are mostly traders and beekeeping groups, use low-cost straining methods and used beverage bottles for packaging honey. Poor methods of processing and packaging can affect the quality, shelf-life and marketing of honey. Honey processed by honey groups and traders is mostly harvested from the traditional hives. In the traditional system improper harvesting of honey and adulteration of processed honey by some dishonest traders and processors warrant product quality control.

The processors in the study area participate in both rural and urban honey markets. However, during periods of high honey flow, rural markets become flooded, whilst the urban markets are inaccessible due to stringent quality control. During such periods, processors prefer to store the product for sale in markets that offer premium prices. One of the features of honey markets in the study area is high ambient temperatures (35^0C). Heat and poor storage conditions can damage the product thereby leading to rejection of honey by consumers in the urban markets. Information on the effect of storage on honey quality and chemical composition of honey obtained in the honey markets of northern Kenya is largely non-existence. Honey quality analysis which is one requirement for certification can be a costly venture for many rural honey processors. Thus, local processors require facilitation on honey certification and quality assurance to compete in urban markets particularly during high honey flow periods (Lengarite et al., 2007). Honey of acceptable quality would attract niche markets and premium prices. These would stimulate honey production and therefore improve the livelihoods of producers, honey processors and traders. The objectives of the study were to determine the quality of honey processed and stored by rural processors and to assess whether they can meet the standards set for urban and regional markets.

Materials and Methods

Study sites

The study was conducted in the Mountains (Ndoto, Nyiru and Marsabit) of northern Kenya. The Ndoto and Nyiru mountains are found at the boundary of Marsabit and Samburu counties, while Mt. Marsabit lies in Marsabit County in northern Kenya. Mt. Nyiru, Ndoto and Marsabit rise to an altitude of 2050, 2367 and 1706 m above sea level, respectively. These mountains have a wide diversity of bee-plants such as *Croton, Newtonia, Commiphora* and *Acacia* spp. and natural water springs. Except for Marsabit, crop production is non-existence in Ndoto and Nyiru mountains. The mean annual temperatures at the foot hills of Ndoto and Nyiru are about 35^0C and 24^0C in Marsabit town.

Sampling of honey

Honey markets at the foot slopes of the Ndoto, Nyiru and Marsabit town were used for sampling honey. In each area, a list of honey groups and traders with stored honey processed in different seasons was compiled. Using simple random sampling technique four samples per site of fresh and stored honeys were obtained. The honey flow season was used to calculate the age of stored honeys, which ranged from one to fourteen months. Honey processors use simple straining cloths and plastics buckets for processing crude honey. Processed honey was packaged in used beverage bottles and stored in makeshift shops and beekeeping group premises. At the end of the sampling period all the samples were immediately taken for analysis at the national beekeeping laboratory.

Laboratory analysis

The samples were analyzed for moisture content, total reducing sugars, apparent sucrose, acidity and Hydroxymethylfurfural (HMF) according to the Harmonized Methods of the International Honey Commission (Bogdanov et al., 1997) or the Association of Official Analytical Chemists (AOAC, 2002).

Data analysis

Data was captured in Microsoft Excel and one-way ANOVA was used to compare the mean quality of honey in different sites and the relationship between storage periods and honey quality was done by regression using GenStat 12th edition.

Results and Discussion

Chemical composition of processed honey

The chemical composition of the processed honey is shown in Table 1. Site had significant effect (p=0.002) on the moisture content of honeys. The mean moisture content (18.0%) of all samples was below the maximum value of 21% and 20% recommended by the *Codex Alimentarius* (2001) and Kenya national beekeeping station, respectively. The level of moisture content in honey shows that ripe honey was harvested by beekeepers for processing. The highest level (19.5%) was observed in Marsabit and lowest value in Ndoto (15.9%). The higher moisture content in Marsabit could be attributed to high humidity which may increase the moisture content of honey during processing and storage. Belie (2009) in Ethiopia, reported high moisture content in honeys collected from areas with high humidity. In climates with high humidity airtight containers with lids are essential for honey storage (Bradbear, 2003). Honey of low moisture content such as those collected from Ndoto can be stored for longer period without risk of fermentation.

The level of acidity, HMF (hydroxymethylfurfural), apparent sucrose and reducing sugar were not influenced by site (p>0.05). The mean total reducing sugars (fructose and glucose) was 69.5%. This could be could be ascribed to similarity in bee plants visited by honeybees to collect nectar. All the samples had fructose and glucose content that fulfils the *Codex* and National quality standards. The relative amount of the two monosaccharides fructose and glucose, which are the hydrolysis products of sucrose, can be useful in the classification of unifloral honeys (Bogdanov, 2009). The satisfactory level of reducing sugars in the honeys implies that ripe honeys were harvested for processing by producers.

Table 1: The chemical composition of honey processed from the mountains of northern Kenya

Site	Moisture content (%)	Total reducing sugars (%)	Apparent sucrose (%)	Acidity (meq/kg)	HMF (mg/kg)
Nyiru	18.5±0.5[a]	69.7±0.8[a]	2.8±0.6[a]	27.8±2.5[a]	5.0±1.6[a]
Ndoto	15.9±0.7[b]	70.3±0.4[a]	2.8±0.3[a]	27.3±1.1[a]	3.4±0.8[a]
Marsabit	19.5±0.4[a]	68.6±0.4[a]	2.7±1.2[a]	23.4±1.3[a]	2.2±1.3[a]
Mean	18.0±0.5	69.5±0.4	2.8±0.4	26.1±1.1	3.6±0.8
National bee-keeping station	≤20	≥65	≤5	≤40	≤40
**Codex Alimentarius*	≤21	≥60	≤5	≤50	≤60

*[a,b]Means±SE along a column with different superscripts differ($p \leq 0.05$); *Codex Alimentarius(2001)*

The analysis of the sucrose content of honeys is useful in detecting adulteration. The amount of sucrose in honeys depends on the type of bee-plants and alteration during production and processing. The mean apparent sucrose content of honeys (2.8%) was below the limit (≤5%) required by international regulatory standards. The results are in agreement with those reported by Muli et al. (2007) in honeys sampled in rural areas of Kenya. However, one sample from Marsabit had sucrose content (5.91%) that exceeded the recommended level. This could be attributed to bees kept in urban apiaries foraging directly on sugar and refined cereals in market places.

The mean acidity (26.1 meq acid/kg) met the quality criteria of *Codex* and National quality standards. The acidity level was comparable to those reported in Ethiopia (Belie, 2009; Kinati et al., 2011) and some rural areas of Kenya (Muli et al., 2007). The acidic level of honey is an important quality factor for testing honey spoilage. Honey acidity is associated with honey taste, antibacterial property and fermentation of honey. Gluconic acid derived from the oxidation of glucose by glucose oxidase is the major acid in honey (Bogdanov, 2009). The acidity of honey can be influenced by the botanical origin of honey, honey flow season and climatic conditions. These mountains contain similar bee plants producing honeys with comparable chemical composition.

The mean HMF content of honey was within the recommended level set by

Codex and National quality standards. Hydroxymethylfurfural is a marker of honey spoilage and is formed during acid-catalyzed dehydration of hexose (Cavia et al., 2006). In fresh honey HMF occurs in trace amounts while the content increases with storage and exposure of honeys to heat (Bogdanov, 2009). All the honey samples showed low HMF similar to those reported by Muli et al. (2007) in Western Pokot and Baringo in Kenya. The low level of HMF could be attributed to analysis of honey stored for short duration.

Storage period and honey quality

The effect of storage on chemical composition is shown in Table 2. Regression between moisture content and storage period was significant ($p=0.005$). The moisture content of honeys decreased with the age of honey. Freshly processed honeys (1 month) had higher moisture than honeys stored for longer periods (14 moths). The decrease in moisture content could be attributed to evaporation of water in honeys during storage. Cavia et al. (2006) working with Spaniard honeys, observed that the water content of honey declined after 20 months. In this study, high temperatures and improper storage conditions can increase the process of evaporation of water in stored honeys.

There was no direct relationship ($p>0.05$) between total reducing sugars and apparent sucrose with storage of honey (Table 2). Reducing sugars (sum of fructose and glucose) and apparent sucrose remained constant in both fresh and honey stored for 14 months. The observation was in agreement with those reported by Cavia et al. (2006) who noted that fructose and glucose content remained constant up to 20 months. It appears that during the storage period the enzyme glucose oxidase that converts glucose to gluconic acid was not activated. Thus the level of glucose and reducing sugars were kept constant.

Table 2: Effect of storage(1-14 months) period on the chemical composition of honey processed in northern Kenya

Parameter	*Min-Max	R^2	P-value
Moisture content (%)	15.0-20	0.884	0.005
Total reducing sugars (%)	67.3-71.2	0.417	0.166
Apparent sucrose (%)	0.46-5.91	6.9×10^{-5}	0.987
Acidity (meq/kg)	21.0-35.0	0.807	0.014
HMF(mg/kg)	0.5-9.3	0.758	0.020

**Min-Max (Maximum and Minimum)*

Regression between honey storage period and acidity was found to be significant (p=0.014). Acidity level increased with storage of honey. Honey stored for 14 months had higher level of 35 meq acid/kg compared to freshly processed honey with 23 meq acid/kg (Table 2). The organic acid which constitute about 0.57% of honey is characterized by its free acidity (Ruoff et al., 2007). The presences of yeast xetolerants, action of micro organisms during maturation and minerals found in honeys contributes to increase the level of acidity in stored honeys.

There was a direct relationship (p=0.02) between HMF content and storage period. HMF increased with storage from 0.5 to 9.3 mg/kg. The findings are consistent with that reported by Nombre et al. (2010) who reported that HMF increased upon storage. Tharasyvoulou (1986) also observed that HMF increased from 0.0 to 8.8 mg/kg after one year of storage. Elevated HMF level modifies the colour of honey by making the honey darker. The hot climatic condition at the foot slopes of the mountains accelerates HMF in stored honeys.

Conclusion and recommendations

The study shows that honey processed in northern Kenya was of acceptable quality, which is within the Codex and national quality standards. However, the quality deteriorates with storage. The quality control parameters of moisture content, acidity and HMF evolved with storage. Thus, increased acidity and HMF would affect the taste, colour and market value of honey. In conclusion, honey processed in northern Kenya using simple straining methods and stored up to fourteen months qualify for sale in urban and regional markets. However, honey processors and traders require awareness on honey storage and quality maintenance. In honey catchment areas, investment on small scale improved processing and storage facilities is crucial for maintenance of honey quality and marketing. In the area, honey processors can diversify their income sources by processing and marketing of beeswax.

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