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Full Length Research

Indigenous processing technologies from farm gates adulterate honey quality at local markets and subject consumers to critical health risks

Benjamin Makimilua Tiimub[1,2*], John Adoripore[3], Gideon Likida Tiimob[4], Isaac Baani[1], Richard Wonnsibe Tiimob[5] and Paul Amihere-Ackah[1]

[1]Department of Environmental Health and Sanitation Education, Faculty of Science & Environment Education, College of Agriculture Education, P.O. Box M 40 Mampong-Ashanti, UEW, Ghana.
[2]Department of Environmental Engineering, Zhejiang University, Hangzhou-China.
[3]Ghana Education Service, Sene West District, Brong-Ahafo Region, Ghana.
[4]Department of Population Family and Reproductive Health, School of Public Health, University of Ghana, Legon.
[5]Department of Public Health, School of Allied Health Sciences, University for Development Studies, P.O. Box TL 1350 Tamale, Ghana.

*Corresponding author. Email: benmakimit@yahoo.com. Tel. +233 244501055, +0086-18258871677.

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ABSTRACT: Physico-chemical and microbial status of 400 honey samples picked from 200 experienced apiculturists for laboratory elucidation based on indigenous processing techniques (IPTs) comprising (burning (B); crushing and straining (C&S); mashing and straining (M&S); boiling and straining (B&S)) reveals its quality defaults at various farm gates with significant variations ($p<0.05$) in pH, electrical conductivity (EC) and free acidity (FA) compared with total reducing sugar (TRS) and total viable microbial loads (TVMLs). The EC varied from (0.999 ± 0.001732 to 0.9997 ± 0.000577) µS/cm with the highest value from B&S IPT. The B; C&S and M&S IPTs resulted to lower FA values (8.10 ± 0.015, 9.50 ± 0.015 and 4.20 ± 0.030) me/kg respectively compared to B&S (10.00 ± 1.00 - 36.67 ± 0.58) me/kg. Greater variation in FA levels confirms the speculations of experts on its fluctuation tendency with honey. Indigenous B gave rise to both highest TRS (31%) and TVMLs (6.95 ± 0.044 cfu/ml). The entire IPTs ubiquitously impacted health threats on honey consumers emanating from microbial contamination. The C&S and M&S IPTs are proved as best honey processing techniques for large scale application at farmgates in Ghana because it conducts the highest counteractive pH to microbial invasions. Innovations on these improved methods could reduce consumer health risks by 90 to 95%.

Key words: Burning, crushing, mashing, straining, honey, physico-chemical, microbial load.

INTRODUCTION

The contribution of honey and its by-products such as waxes and gums, among the rich cocoa food products such as chocolate and milo (cocoa beverages) which play a leading role in augmenting confectionaries and pharmaceutical products on a drive for industrial food processing has been strongly highlighted by early researchers and renowned food scientists in the world (George and Shu-Aib, 2009; Afoakwa, 2012; Adadi and Obeng, 2017). This makes honey quality and its transient characteristics a significant scientific issue for scientific studies (Adebiyi et al., 2004; George and Shu-Aib, 2009).

Honey is a sweet, thick and glutinous juice collected from beehives and usually found in cells of the honeycombs (Marcazzan et al., 2005; George and Shu-Aib, 2009; Mahmoudi et al., 2014a). Pure honey is produced from the nectar of blossoms or from the secretion of living parts of plants or excretion of plant sucking insects on the living parts of plants, which honeybees collect, transform and combine with specific substances, store and leave in the honeycomb to ripen and mature (George and Shu-Aib, 2009; Codex Alimentarius Commission, 2001). It is the main economic product of the honeybee, a complex mixture with variations in hydroscopic composition and characteristics due to its geographical and botanical origin. The type of honey made by the bees is dependent on the types of foliage and flowers available to the bees (George and Shu-Aib, 2009; Adadi and Obeng, 2017; Hagopian, 2018).

By-products such as beewax, propolis and royal jelly are additionally generated from apiculture in spite of the major economic role of bees in transfer of pollen grains in crop pollination (Adadi and Obeng, 2017; Hagopian, 2018). Among the important uses, pure and undiluted/unadulterated honey serves as natural sweetener and contains a broad variety of vitamins for human consumption and medicinal purposes (an ancient remedy for the treatment of infected wounds) and constitutes the main source of food to the bees all year round (Ojeleye, 1999; Schmickl and Crailsheim, 2004; Olaitan et al., 2007; Katiraee et al., 2014; Mahmoudi et al., 2014b). Unlike normal sugar, pure honey has many health benefits and is used in remedies, diets and for medicinal purposes worldwide, serves as natural preservative and has antibacterial qualities (Mandal and Mandal, 2011, 2011).

There are many types, colours, and flavours of honey and depending upon its nectar source, it often contains impurities and microbes such as bacteria and fungi (Manyi-Loh et al., 2011; Mahmoudi et al., 2012; Iurlina and Fritz, 2005). Honey is an easily digestible, pure food with long history in human diets, usually used in various foods and beverages as a sweetener and flavoring (Manisha and Shyamapada, 2011). The sweetness in honey often considered similar to granulated sugar is due to its reducing sugar components such as monosaccharide, fructose and glucose (Mahmoudi et al., 2012; George and Shu-Aib, 2009).

Global honey production has been increasing steadily over the years since 1976 until recently when production in leading continents began to stagnate due to changing weather conditions and the emergence of bee diseases. World honey production in over the past four decades been estimated at 1,394,000 mt and is growing between 2% and 3% per annum (Anderson and Dietz, 1976; Carl and Stanley, 2000; Hagopian, 2018). Asia is the leading honey producing continent with China, Vietnam, and Thailand being the highest producing countries, North America is the second largest producing continent with the US and Canada as the highest producing countries with Europe, Africa, South America and Oceania ranking next in order of decreasing production records (Hagopian, 2018). A recent honeybee Colony Collapse Disorder (CCD) pose a serious threat as this loss of bee phenomenon has been recognized as such an urgent crisis featured in an article outlining the U.S. Department of Agriculture's (USDA) declaration to provide a $3 million subsidy to support the one animal (insect) on the planet that will either make or break food prices (Hagopian, 2018). The latest USDA industry survey, emergency plan assistance comes after nearly a third of commercial honeybees died last winter, a whopping increase of 42% from the previous year. The grant subsidy program is designed to entice both Midwest dairy farmers and cattle ranchers to reseed their fields during springs with eco-friendly crops like alfalfa and clover to develop healthier habitats for increasing the national bee population (Hagopian, 2018).

Article rationale

In Africa (example Ghana), agro-ecological conditions are considered suitable for the production of honey in all the regions (Adadi and Obeng, 2017). The West African honeybee, *Apis mellifera adansonii* is better adapted to the tropical conditions of Ghana, even though, wild honey hunting with its adverse environmental consequences still dominates the sub-sector (George and Shu-Aib, 2009). More so, the way of harvesting, processing and storage of honey locally in Ghana may subject it to sharp changes in qualitative physico-chemical status coupled microbial invasions leading to reduction in market value within several productions, processing centers whereby the Sene West District is not an exception (Adebiyi et al., 2007; Adadi and Obeng, 2017).

The production and processing channels of honey account for the presence of microorganisms often resulting from cross contamination (Olaitan et al., 2007; Mahmoudi et al., 2012; Adadi and Obeng, 2017). Intimated by Iurlina and Fritz (2005), micro-organisms in honey may influence the stability of the product and its hygienic quality. Due to the natural properties of honey and control measures in the honey industry, pure honey products are characterized by minimal microbial loads (USDA 1985; Codex Alimentarius Commission, 2001; Won et al., 2008). Microbes of concern in post-harvest handling are those that are commonly found in honey, similar to yeasts and spore-forming bacteria noted as good predictive sources of the sanitary status determining the commercial quality of honey, often isolated as coliforms and yeasts that are under certain conditions causative agents of human illness (Manyi-Loh et al., 2011; Mahmoudi et al., 2014a). Pollen, the digestive tracts of honey bees, dust, air, earth and nectar sources which are very difficult to control constitute the predictive sources of honey microbial contamination (Adadi and Obeng, 2017). Predictive sources of microbial cross-contamination of honey occur between and processing centres and influenced by the choice of processing technology, handling, packaging and distribution within local market food chains (Snowdon and Cliver, 1996; Codex Alimentarius Commission, 2001).

Honey distribution in the Sene West District is very popular and undertaken mostly by vendors. This phenomenon poses health risk to the consumers due to the unhygienic methods used for harvesting and processing by the indigenous people. Poor handling further subjects the honey products to numerous quality problems arising from its sheer exposure as a means of advertisement to attract customers in open markets. Indigenous processing techniques such as mashing, straining, burning and crushing of the combs to squeeze out honey leads to physico-chemical variations and microbial invasion. Health risk analysis and microbial quality as well as physicochemical studies is urgently required to establish the safety status of honey in this area. Cross contamination of honey products requires further analysis of the relationships that exist within pollutant sources and sinks, mode of contaminant or pathogens transfer within the honey production/market cycles in order to educate the local people towards hygienic ways of handling so as to minimize the adverse effects of consuming unclean honey by the majority of innocent people (Iurlina and Fritz 2005).

Beekeepers, honey sellers and consumers in the area understudied may be working hard to improve their hygienic practices, but still beset with incipient safety challenges. Higher research institutions and individual bodies are working around the clock to put the condition under control. One of these institutions is the University of Education Winneba Ashanti-Mampong Campus, in the Ashanti Region where this purposive research was conducted to identify the various quality issues of honey in the local markets at farm gates to determine medium to large scale honey value chain risk and impact.

The research critically examined variations in physico-chemical conditions (pH, free acidity and electrical conductivity) and the microbial contamination (total bacterial load) of honey available at the farm gate market level of processing by indigenous techniques in the Sene West District within the Brong-Ahafo Region of Ghana in West Africa to ascertain essential issues constituting public health risks to consumers of locally marketed honey.

This article informs beekeepers, honey sellers, consumers, researchers, scientists and readers at large about some aspects of indigenous knowledge which require innovation in order to regulate daily honey processing and handling in hygienic manners to curb the concurrent contamination and health threats posed to consumers at the edge. It contains relevant information on indigenous honey processing techniques and safe handling to researchers, beekeepers, honey sellers and consumers at the larger market. Readers could compare the local Ghanaian honey with international quality standards using standard food quality indicators. International honey standards are specified in European Honey Directive and the Codex Alimentarius (1994 and 2001) for the determination of the following quality factors: moisture, ash, pH, acidity, hydroxymethylfurfural, apparent reducing sugars, specific sugars and electrical conductivity. Apparent sucrose, diastase activity and water-insoluble matter are used in the international honey regulations for the determination of honey quality for public consumption and associated health risks (Codex Alimentarius, 1994 and 2001).

MATERIALS AND METHODS

Research area

The research was conducted between May, 2013 and May, 2017 in the Sene West District with the largest land area of about 8,586.44 out of the 22 administrative districts of the Brong-Ahafo Region. Sene West area is characterized by Wet Semi-Equatorial and Tropical Continental climatic conditions (Figure 1). The district lies within longitudes 0^{o} 15'E and 0^{o} 15'W, and latitudes 7^{o} N and 8^{o} 30'N with high average annual temperatures of 27°C, relative humidity of 75%, and bi-modal rainfall patterns of 1191.2 mm interspersed between wet periods (late March to early July and late August to early November) and dry seasons (middle July to early August and late November to middle March) (Ghana Statistical Service, 2010). The local vegetation is covered by sparsely populated trees such as *Mangifera indica, Samanea saman*, *Tectona grandis*, *Acacia auriculaeformis, Anacardium occidentale*, *Pakia biglobosa* and dominant grasses and herbs such as *Imperata cylindrica, Sida acuta*, *Tridax procumbens et cetera* (Ghana Statistical Service, 2010).

Honey sampling

The honey samples were selected from local farm gate market processing joints within the Sene West District where the beekeepers were directly contacted for supply. Kwame Danso, Batama, Wiase, Akenteng, Lassi, Lemu, Kyeame-Krom and Mframa were the main communities surveyed. Processed honey samples were chosen and picked at random based on the local methods of processing. The researchers personally visited the beekeepers for supply of the honey and investigated by observing the main honey processing methods such as; crashing, boiling, burning and mashing. A systematic random sampling was employed to determine the sampling points whereby a list of 400 honey samples coded with alphabetical letters representing the various brands processed by some purposively selected 200 beekeepers and hunters with long term working experience (up to ten years with certified health records from the Ghana Health Service) who were preparing their products for the market distribution centres and were reachable during the survey were involved. Each of the alphabets represented a processing method such as burning (B), crushing and straining (C&S), mashing and straining (M&S) and boiling and straining (B&S). Each of

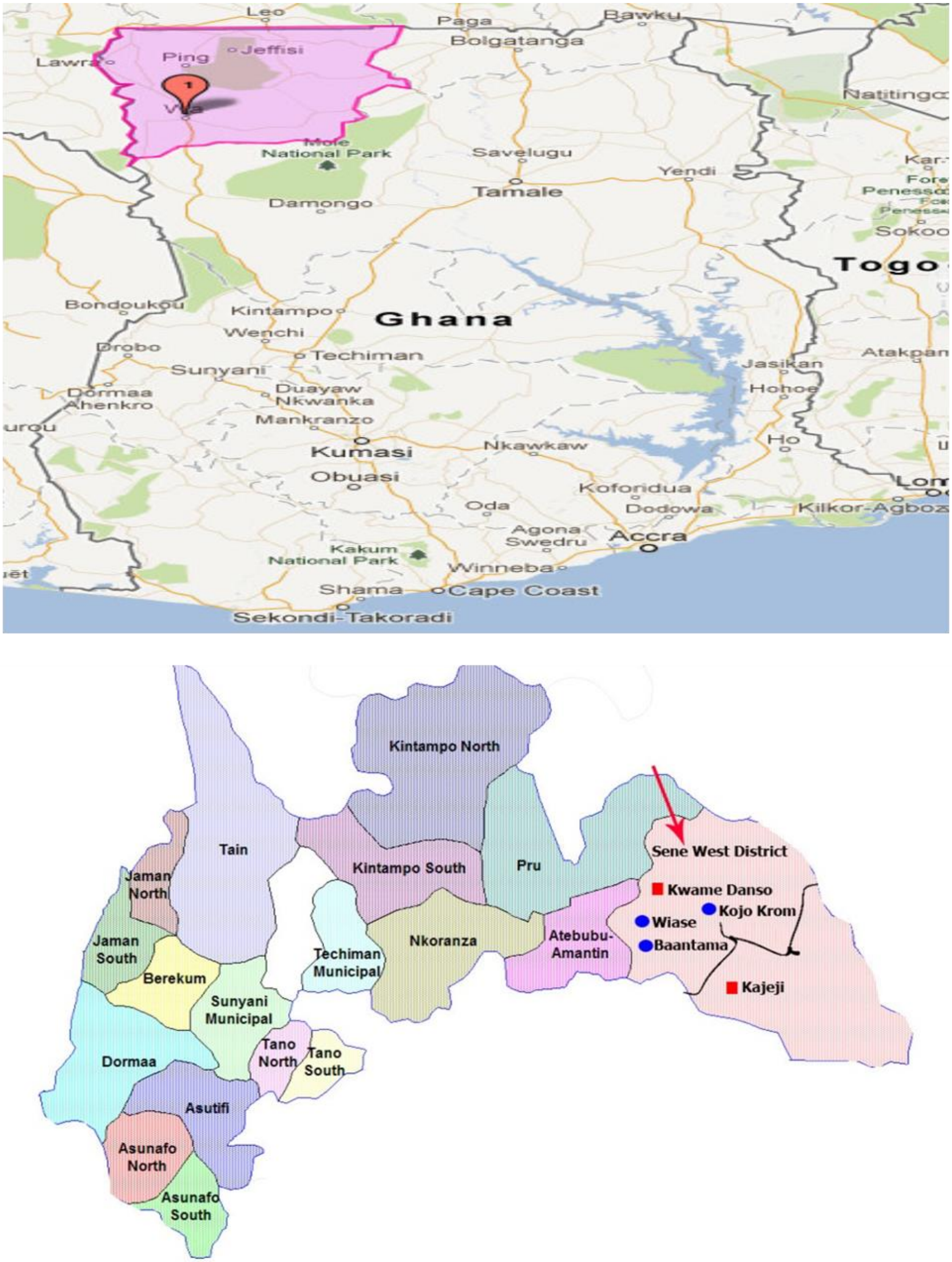

Figure 1. Brong-Ahafo Region with an arrow indicating the Sene West District where the survey was conducted in Ghana (West Africa) Source: Ghana Statistical Service (2010).

Plate 1. Interacting with a local beekeeper on the indigenous methods of honey processing.

the honey bottles was labeled immediately after collection by placing sticker on them in the order of (A, B, C, and D) (Plate 1). The samples were immediately transported in an ice chest to the Chemistry Laboratory of University of Education, Winneba, Mampong Campus for analyses of various physico-chemical and general microbial effects associated with honey (Codex Alimentarius Commission Standards, 2001; Mahmoudi et al., 2012; Adadi and Obeng, 2017).

Analysis

pH and free acidity of honey

pH of the honey was determined by measuring 10.0 g of homogenized honey sample dissolved in 75 ml of CO_2 free water and stirred with a magnetic stirrer. The pH was read by immersion of the pH electrodes in the solution. In determination of free acidity, the honey was titrated with 0.1M NaOH to pH 8.30 (using a digital pH meter) while ensuring that a steady pH reading was obtained within 120 seconds of the titration duration. The readings were recorded to the nearest 0.2 ml. Free acidity was calculated using the expression: FA = ml of 0.1M NaOH x 10 (mill equivalents) (Codex Alimentarius Commission Standards, 2001; Mahmoudi et al., 2012).

Electrical conductivity (EC)

About 20 g of honey were dissolved in 100 mol volumetric flask and made up to the volume with distilled water. Up to 40 ml of this solution was poured into a beaker and placed in a thermostatic water bath at 20^{o}C. The electrode was put into the solution and the reading taken periodically within an hour. Ash content was determined indirectly by relating the results obtained from the electrical conductivity measurement using the formula A = (C - 0.4)/1.74; where: A= ash content in grams per 100 g of honey and C = electrical conductivity in milli Siemens cm^{-1} (Codex Alimentarius Commission Standards, 2001; Mahmoudi et al., 2012).

Total reducing sugars

Total reducing sugars were determined following the Lane-Eynon Method which involves three procedures: (i) standardization of Fehling's solution 1; (ii) preliminary titration, and (iii) final titration (Bogdanov and Martin, 2002).

Microbial analysis of the honey

A serial dilution is the stepwise remixing and transfer of a substance in solution at different levels of chemical or microbial concentrations. Guided by this protocol for the experiment involving three (3) test tubes : first (A) filled with 10 milliliters (mill) of a ammonium chloride solution, a second test tube (B) was filled with 9 mL of a buffer of distilled water depending on the composition of the solution in test tube A and a third tube (C) was filled with 9 mL of the buffer by transferring one mL of the solution from (B). The contents of each tube with dilution factors of 1/1; 1/10 and 1/100 in A, B and C respectively, were swirled to thoroughly mix. This procedure was extended to perform longer serial dilutions repeatedly as many times as necessary to achieve the desired solution. The final dilution ratio in a serial dilution was calculated. The total dilution ratio in a series of dilutions was obtained by the product *Dt = D1 x D2 x D3 x … x Dn*. The concentration of the solution in a dilution was further derived as given by *X = C/D*: [where: X = concentration of the dilution; C = concentration of the original solution and D = dilution ratio] (Codex Alimentarius Commission Standards, 2001; Mahmoudi et al., 2012; Adadi and Obeng, 2017).

Methods used for honey processing in the Sene West District

The honey processors practices were directly observed, coupled with direct personal interactions with the experienced apiculturists (Plate 1) and discovered that, (i) burning, (ii) boiling and straining, (iii) mashing and straining, (iv) crushing and straining methods were used in processing harvested honey at farm gates for further distribution in the local markets.

Burning method

The honey combs were consolidated into a pan and kept on burning fuel wood or charcoal furnace to melt out for the honey to be collected into sterile empty gallons in the

Plate 2. Boiling Method of honey processing.

Plate 3. Mashing and straining Method of processing honey.

Plate 4. Crushing and straining method of processing honey.

form of liquid, leaving the waxy combs.

Boiling method

The matured combs containing honey were slightly squeezed from one side of the comb to enable some of the liquid honey drain into the pan at a boiling temperature. More honey combs were then added and stirred in a medium to melt out its contents leaving the waxy combs (Plate 2).

Mashing and straining method

This method was applied to soft sticky combs with flowing liquid contents due to damaged combs encountered in the process of harvesting. The honey combs with its contents were mashed to squeeze out its liquid honey contents into a pan using the gloved hands worn over to avoid direct body contact with the honey (Plate 3).

Crushing and straining method of processing honey

This involves a similar process as the mashing and straining but the technique was applied on the hard but damaged combs which had its honey contents flowing. Thus, the hard combs were crushed with the protected hands gloved over whilst using sieve to remove the solid or semi-solid combs by means of decanting (Plate 4).

Statistical analysis

Origin 8.0 and SPSS 22 (SPSS, Chicago, IL) software were used in statistical analysis of data, plotting and data processing. The level of significance was defined for all tests as $p < 0.05$.

RESULTS AND DISCUSSION

pH status of the honey

pH of the honey samples in Figure 2 was significantly affected by the various processing methods ($p < 0.05$). Mashing and straining methods gave rise to the least mean value (4.18 ±0.010) compared to the mean range for boiling processing (4.18 ± 0.010 to 4.44 ± 0.021); which were all within the acceptable range of 3.4 to 6.1 for pure honey. The honey proved to be acidic with low pH and likelihood to inhibit the presence and prolific growth of invasive microorganisms (National Honey Board, 1995; Codex Alimentarius Commission Standards, 2001; Mahmoudi et al., 2012).

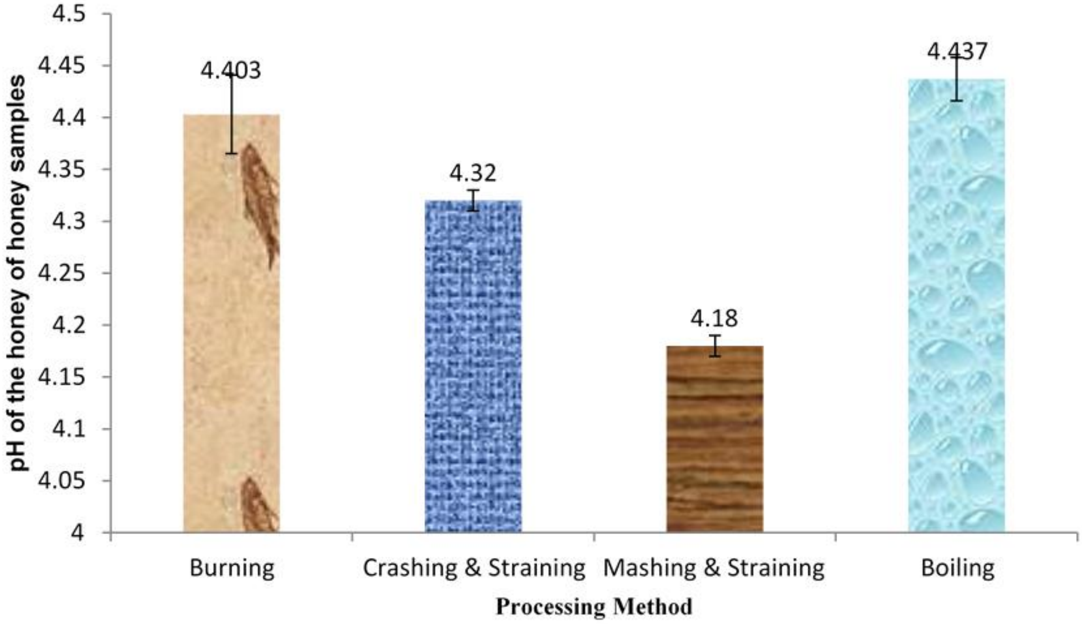

Figure 2. Mean pH as influenced by different processing methods for honey.

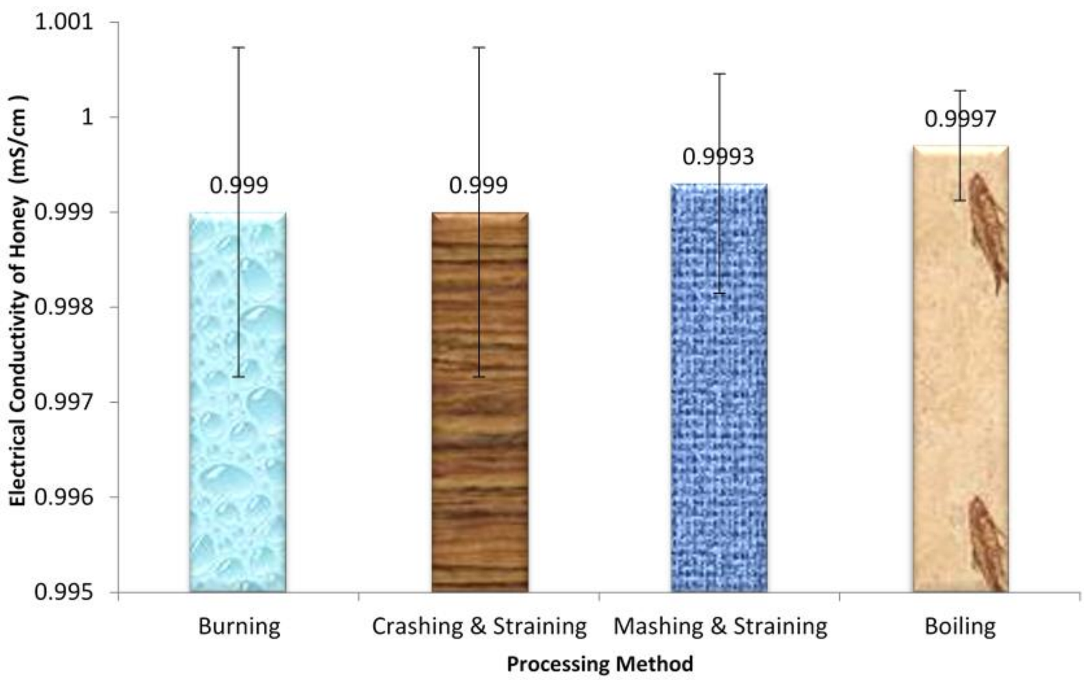

Figure 3. Mean electrical conductivity of honey under various treatments.

Electrical conductivity of honey (EC)

EC of the honey shown on Figure 3 did not significantly vary at ($p > 0.05$) with reference to the different processing methods. Boiling generated the highest EC value of 0.9997. The average EC ranged from 0.999 ± 0.001732 to 0.9997 ± 0.000577 mS/cm, confirming that the honey types were pure honeydew and chestnut. According to Bogdanov and Martin (2002), pure honeydew honey and chestnut honeys should have an electrical conductivity value more than 0.8 mS/cm when tested for its standard value for food safety.

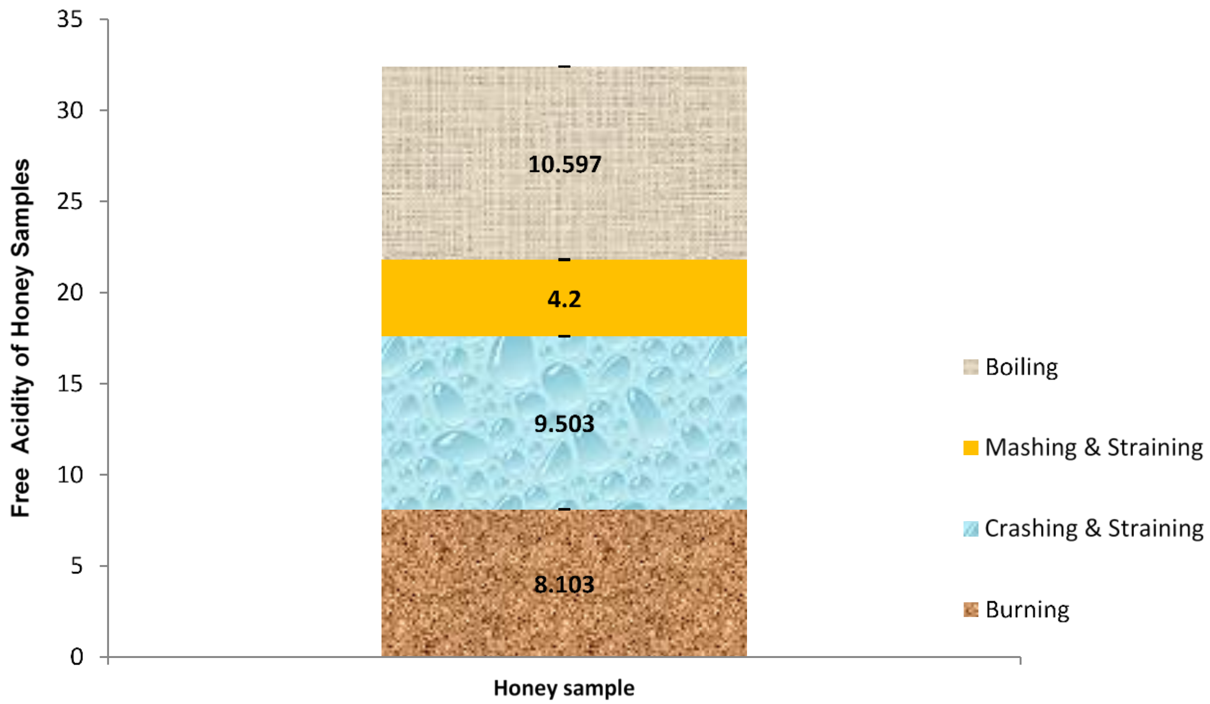

Figure 4. Mean free acidity of honey samples under different treatments.

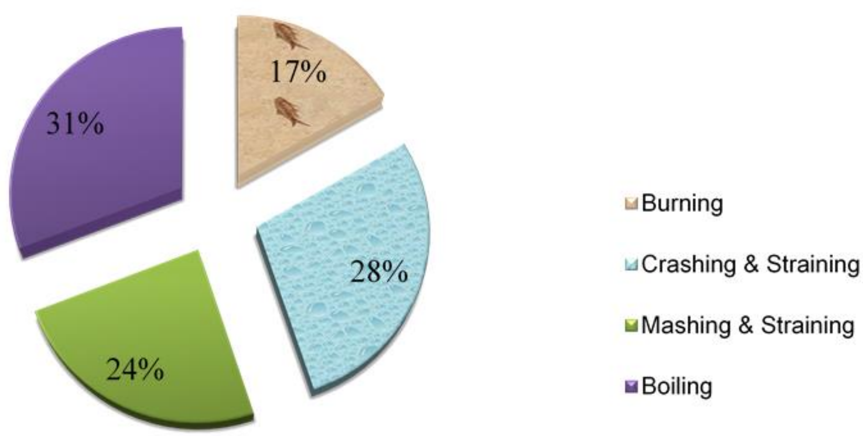

Figure 5. Mean reducing sugar of honey expressed in percentages as influenced by different treatments.

Free acidity of honey

Free acidity has been used as a quality criterion for assessing whether fermentation has taken place because the process is linked to an increase in acidity (Bogdanov and Martin, 2002). The maximum acceptable level of free acidity as per the Codex Alimentarius standard is 40 miliequivalents/kg. Free acidity of the honey samples as shown in Figure 4 was significantly influenced by the different processing methods ($p < 0.05$). Three of the processing methods (burning; crushing and straining; and mashing and straining) recorded relative values of 8.10 ± 0.015, 9.50 ± 0.015 and 4.20 ± 0.030 mg/kg respectively, which were much lesser than the recommended limit. The boiling method had its free acidity well within the recommended limit; the range was 10.00 ± 1.00 to 36.67 ± 0.58 mg/kg. The great variation in free acidity in the different processing methods could be attributed to the existence of great natural variation in the acidity of honey as previously established by Horn and Lüllmann (1992).

Total reducing sugar level of honey

The honey contained low reducing sugars (calculated as invert sugar), constituting 31, 28, 24 and 17% for burning, crushing and straining, mashing and straining and boiling and straining method respectively within a lesser marginal range of 17 to 31% compared with the minimum 65% Codex Alimetarious requirement (Figure 5). Observed specific differences in the reducing sugar contents of Africa honey samples from the case of Sene West District in Ghana is probably linked to its natural properties irrespective of adulteration effects. Ghanaian honey researchers already stipulated that significant difference in composition of honey exists when honey samples come from different bio-geographical backgrounds which connect the honey bee species to country of origin (Paterson, 2006; George and Shu-Aib*,* 2009; Manyi-Loh et al., 2011; Mahmoudi et al., 2012). The reported total reducing sugars of honey ranged from 17.51 ± 0.021 to 31.2 ± 0.015 g/100g. This trend confirm reports of existing variations pointed by Paterson (2006), George and Shu-Aib (2009), Manyi-Loh et al. (2011) and Mahmoudi et al. (2012), thus, clarifying that the chemical composition of the honey examined was closer, but does not totally conform to the international (Codex Alimentarius) requirement due to their depictive lower reducing sugar contents (Codex Alimentarius, 1994). The African honey samples, viewed in the perspective of indigenous processing knowledge and techniques, were of lower quality for international markets.

Microbial status of honey using indigenous processing techniques

Results of all the honey samples cross-examined qualitatively under the four methods of processing depicted evidence of pathogenic invasions ranging from 4.99 ± 0.01 to 6.95 ± 0.044 cfu/ml of viable microbial spot counts in them (Table 1). The burning method gave rise to the highest total viable microbes while the lowest spot counts were detected from crushing and straining processes. These trends confirm the long standing claims that fungi and spore-forming bacteria may be present in honey (Mahmoudi et al., 2012; Adadi and Obeng, 2017). The phenomenal microbial invasions may be suspected on the negative effect of cross contamination in the course of harvesting and processing in spite of the fact that, the workers obtained their honey supplies from unsafe primary sources (bee farms) cited closer to settlements where the bees could pick water and nectar from contaminated wastewater sinks. According to Bogdanov et al. (1999) and Krell (1996), microbiological contamination during or after processing of honey is demonstrated by absence of detective pathogens in the analytical samples from primary sources and by the presence of bacterium (*Bacillus sp.*) isolates and spot fungi in the samples pooled from local markets. The results obtained in this research typified a trend of elucidatory unsatisfactory consumer safety honey quality standards influenced by contamination from the secondary sources during processing and packaging. Hence, the entire supply sources which rather fail to meet the requirements for international food safety due to suspected adulterations at the local farm gates are negatively affected by indicative poor processing technologies, adulteration and cross contamination identified in this study as the key trajectories to a safer distribution of pure honey at the production units. The problem ought to be checked or arrested through appropriate food safety monitoring intervention strategies (Mulu et al., 2004).

Conclusion

Analysis of the findings confirmed cases of honey adulteration with the risk of attendant bacteria contamination sequestered against the health of the consumer. Physico-chemical and microbial status of the honey samples were the chosen criteria to establish whether it met the minimum standards set for marketing and consumption purposes. Although entire pH was within the pure honey value range (3.4 to 6.1), electrical conductivities were quite above 0.8 ms/cm. The EC record furher suggested that pure, dew and chestnut honey types were characteristically the final products obtained. Burning proved to be an unimproved honey processing technique once it poses the highest microbial contamination risk, up to the level of 6.95 cfu/ml. The C&S and M&S IPTs are the best indigenous honey processing techniques for large scale application at farmgates in Ghana because it conducts the highest counteractive pH to microbial invasions. Innovations on these later methods could, reduce consumer health risks by 90 to 95%.

Recommendations

The following aspects, outcomes and sugestions are possible to adopt towards improving the agroprocessing industry for honey:

1. Crushing and straining as well as marshing and straining methods of processing honey are better options for obtaining honey with pure quality standard from the indigenous perspective due to its lower infective bacterial cross contamination records.
2. Beekeepers, bee/honey hunters, honey sellers as well as honey cosummers should not expose honey because it may absorb air, water, dust and other particles which may lead to cross contanmination and fermentation resulting to detrimental health effects on the consumers.
3. Further study should be conducted on the methods of honey harvesting to explore the longer term degene-

rate effects of induced microbial contamination interphases, and changes in physico-chemical conditions of the honey. In this wise, future researchers should extend sampling frames beyong rural honey proccesing units to cover peri urban and urban scopes in order to adequatley and confidently validate and report issues related to this artilce.

4. Further studies on bacteria characterization is required to identify the growth and replication rates of the various strains under wide range of unstable or specific environmental conditions in order to adequately compare with the World Health Organization and other International Food Safety quality standards specifications. Further examination of the characteristics of substrate/nectar sources may aid the identification of appropriate ecological monitoring actions that promote the sitting of beehives at safer locations to mitigate cross contamination and promote the safety of economic bees as recently advocated by Hagopian (2018) on the death and extinction of the bees in the world.
5. Honey bee researchers ought to scout new alternative for adoptive, innovative actions geared towards: improving honey extractions techniques; increasing its reducing sugar levels towards close conformance to international food safety standards. Emerging biotechnologists should capitalize on the use of indigenous concepts to innovate honey bee colony bait products while using our study areas as experimental validation sites for aggregation of impact.
6. Local and international partners with participatory development interest in promoting small and medium scale enterprises could generate employment and income using food hygiene and processing technologies should actively get involved in the development of engineering solutions. Invention of new design options and processing machines for hygienic and large scale processing of honey as a business by innovative actors could grossly promote public health goals since the supply of the product at farm gates is very constant in rural Africa to sustain incremental market demands. This is actually a virgin business initiative that African Governments could explore to herald socio-economic growth for sustainable income generation for the rural folks; mitigate higher rural poverty, arrest food insecurity and patch agro-industrial technological gaps.

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CONFLICT OF INTEREST

Authors declare that no conflict of interest exist among themselves in this authorship or will likely surface in the dissemination of their findings in future.

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