

Original Research Article

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## Characterization of Multifloral Honeys from Angola by Their Physicochemical Parameters

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### ABSTRACT

The aim of the present study was to contribute to increase the current knowledge about the chemical composition of multifloral honeys from Angola through the use of main physicochemical parameters. Water content, pH, free acidity, electrical conductivity, proline, hydroxymethylfurfural (HMF), sugar content and diastase activity were analyzed. The mean values and standard deviations obtained for the physicochemical parameters were: water content  $18.88 \pm 1.21\%$ , pH  $4.36 \pm 0.59$ , free acidity  $29.36 \pm 13.51$  meq/kg, electrical conductivity  $0.92 \pm 0.15$  mS/cm and proline  $565.77 \pm 312.39$  mg/kg. For all honey samples hydroxymethylfurfural (HMF) values are under 20 mg/kg. The sugar content and diastase activity were also analyzed. The results obtained for multifloral honey samples from Angola indicated a good quality level according to their physicochemical parameters.

#### Keywords

Honey, Physicochemical parameters, Proline, Water content, Free acidity, Electrical conductivity, Sugars, Diastase, Hydroxymethylfurfural (HMF), pH

#### Article Info

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### Introduction

Honey is a natural product produced by the bees and it is a nutritious food of economic importance worldwide. In the recent years, beekeeping and honey production in Africa have been increased notoriously (Maus, 2016; Moinde, 2016). This natural complex

foodstuff is produced in almost every country and largely used as a food source. The honey cannot be considered as a complete food by human nutritional standards but it offers potential as a dietary supplement (Silva *et al.*, 2009). Chemically, the honey is a complex mixture of sugars. Fructose and glucose are the main ingredients. It also contains mineral

elements, enzymes, vitamins, volatile and some phenolic compounds as minor components (Kaskonien *et al.*, 2010; Missio da Silva *et al.*, 2016; Oroian and Ropciuc, 2017). It is well known that specific composition of honey depends on many factors, such as the nectar composition of the source plant, bees' species, environmental and seasonal conditions and agricultural practices (Anklam, 1998; Azeredo *et al.*, 2003; Iglesias *et al.*, 2012). Based on its components honey has different biological properties such as antibacterial, antiviral, anti-inflammatory, wound healing, antioxidant, radical scavenging, antidiabetic activities (Molan, 1992; Liu *et al.*, 2013; Bogdanov, 2017). Despite of many scientific investigations into the physicochemical properties of honey, further investigations are needed in countries such as Angola where such data is insufficient.

In this respect, the aim of the present study is to contribute to increase the current knowledge about the chemical composition of multifloral honeys from Angola through the use of main physicochemical parameters.

## Materials and Methods

In this study 10 honey samples from different regions of Angola (Caxito, Moxico, Viana, Catete (Bengo), Huambo, Uige, Bie) were analyzed. The honey samples are harvested by cutting the bee wax combs and put in containers. Pollen analysis was done according to Von Der Ohe *et al.*, (2004).

According to their physical state, i.e. texture, honey samples corresponded to liquid honey. The parameters water content, hydroxymethylfurfural (HMF), pH, proline, free acidity, diastase activity, electrical conductivity, sugars (glucose, fructose and sucrose) were analyzed according to Harmonized methods of the European Honey Commission (Bogdanov *et al.*, 1997).

The colour intensity of honey samples was measured according to the Pfund scale. Briefly, homogeneous honey samples were transferred into cuvettes with a 10 mm light path until the cuvettes were approximately full. Each cuvette was inserted into a Lovibond Honey Colorpod. The colour grades were expressed in millimeter (mm) Pfund grades.

All reagents were of analytical reagent grade. The sugars standards (glucose, fructose and sucrose) were purchased from Fluka. Methanol (HPLC grade) and acetonitrile (HPLC grade) were purchased from Promochem.

After honeys' harvest, the samples were stored in a dark place at refrigerator (2 – 8°C) until the analysis. All samples showed no sign of fermentation or spoilage. The results were expressed as mean  $\pm$  standard deviation. The statistical analysis was carried out using the program SPSS 21 for Windows.

## Results and Discussion

Pollen analysis was used to confirm the botanical origin of the honey samples from different regions of Angola. Generally, there is not a dominant pollen type and all honey samples could be considered as multifloral. The following families and species are recognized in all honey samples: *Fabaceae* (*Brachystegia boehmii*, *Brachystegia spiciformis*, *Erythrina abyssinica*, *Isobertlinia angolensis*, *Julbernardia paniculata*, *Pterocarpus angolensis*); *Caesalpinaceae* (*Bobgunnia madagascariensis*, *Piliostigma thonningii*); *Cochlospermaceae* (*Cochlospermum angolense*); *Combretaceae* (*Combretum collinum*); *Sterculiaceae* (*Dombeya rotundifolia*); *Ochnaceae* (*Ochna schweinfurthiana*); *Chrysobalanaceae* (*Parinari curatellifolia*); *Polygalaceae* (*Securidaca longepedunculata*); *Myrtaceae* (*Syzygium*

*guineense*); *Euphorbiaceae* (*Uapaca kirkiana*). As a next step, the same honey samples were studied in terms of some physicochemical properties. First, the honey colour was determined. This parameter is perceived most immediately by the consumers. The honey colour can vary different from white or straw yellow to amber and from dark amber to almost black with a hint of green or red. This parameter can depend on botanical and geographical origin and also related to the mineral content, pollen and phenolic compounds present in the honey (Ramalhosa *et al.*, 2011; El-Metwally, 2015). The results of the colour analyses were 26.50– 87.00 mm Pfund. Similar results are obtained for Yemeni honeys (El Sohaimy *et al.*, 2015). Visually all honey samples did not show sign of fermentation processes.

Second, the results obtained for the main physicochemical parameters are presented in Table 1.

Water content for all samples was low with an average value of 18.88% (Table 1). This value supported the previous study for Egyptian honey samples (El Sohaimy *et al.*, 2015). In the present study the highest moisture value came out for honey from Viana (20.70%).

As it was expected, the all honey samples analyzed were found to have an acidic character. Their pH values ranged from pH 3.76 to 5.46 (Table 1). The highest pH value was obtained for honey from Moxico (Lucusse). It is well known that, the low pH values inhibit the presence of microorganisms. Furthermore, according to Feas *et al.*, (2010) the values of pH in honey help determine its origin: flower or forest.

The free acidity varies in a large range between 7.80 – 45.20 meq/kg. It depends on the presence of organic acids and corresponding lactones, esters and inorganic

ions. According to the European Union Honey Directive (European Commission, 2002) the free acidity should be under 50 meq/kg. Our results are under this limit. The high free acidity can be indicative for fermentation of sugars into organic acids (Ahmida *et al.*, 2013).

The next parameter is electrical conductivity of the honey. It is closely related to the concentration of mineral elements, organic acids and proteins. This parameter shows great variability according to the floral origin and it is important for the differentiation of honey's floral origin (Terrab *et al.*, 2008; Juszczak *et al.*, 2009; Silva *et al.*, 2009). The mean value ( $0.92 \pm 0.15$  mS/cm) is up to 0.8 mS/cm.

Different amino acids can be found in honey (lysine, histidine, arginine, tyrosine phenylalanine, threonine and isoleucine, leucine, valine and tryptophane), (Iglesias *et al.*, 2004; Boonchiangma *et al.*, 2015). Proline is the most important from a quantitative point of view (Kivrak, 2017). In this study, the values for proline range between 264 and 1132 mg/kg (Fig. 1). The mean value and standard deviation is  $565.77 \pm 312.39$  mg/kg. Our results are comparable to those for multifloral honey samples from Burkina Faso (Meda *et al.*, 2005). A great variation in the proline content (20.8 – 673.3 mg/kg) was also observed by Muli *et al.*, (2007).

The diastase activity and HMF are widely recognized as parameters for the evaluation of honey freshness and overheating. The diastase activity shows very different values, ranging between 0.30 and 14.40 DN. Several factors influence the formation of HMF, such as storage conditions (e.g. temperature). It is well known that honey heating results in the formation of HMF which is produced during acid-catalysed dehydration of hexoses, such as fructose and glucose (Belitz and Grosch, 1999).

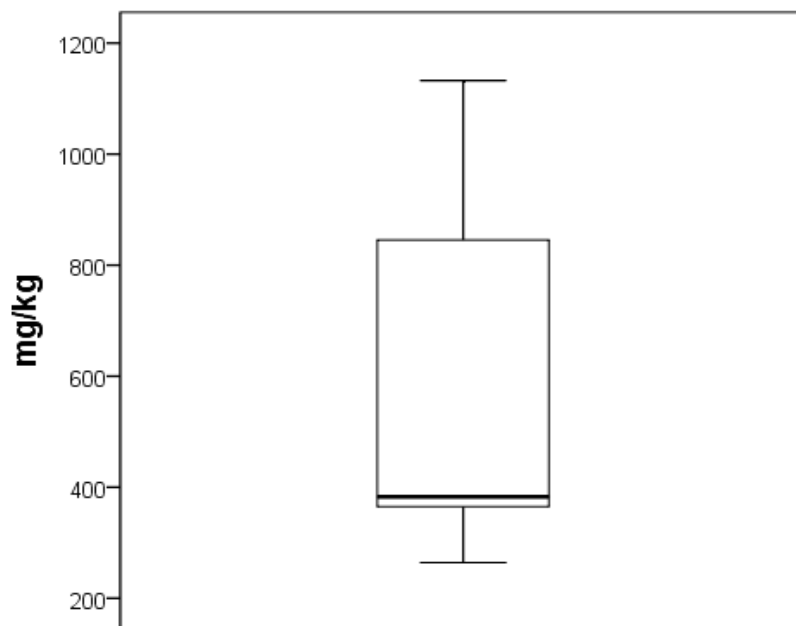
**Table.1** Physicochemical parameters of honey samples from Angola, (n=10)

Parameters	Mean±SD	Ranges
Water content, %	18.88±1.21	16.90–20.70
pH	3.96±0.13	3.76–5.46
Free acidity, meq/kg	29.36±13.51	7.80–45.20
Electrical conductivity, mS/cm	0.92±0.15	0.76–1.25
Proline, mg/kg	565.77±312.39	264–1132
Diastase activity, DN	5.20±6.28	0.30–14.40
HMF, mg/kg	13.50±4.50	10.50–19.25

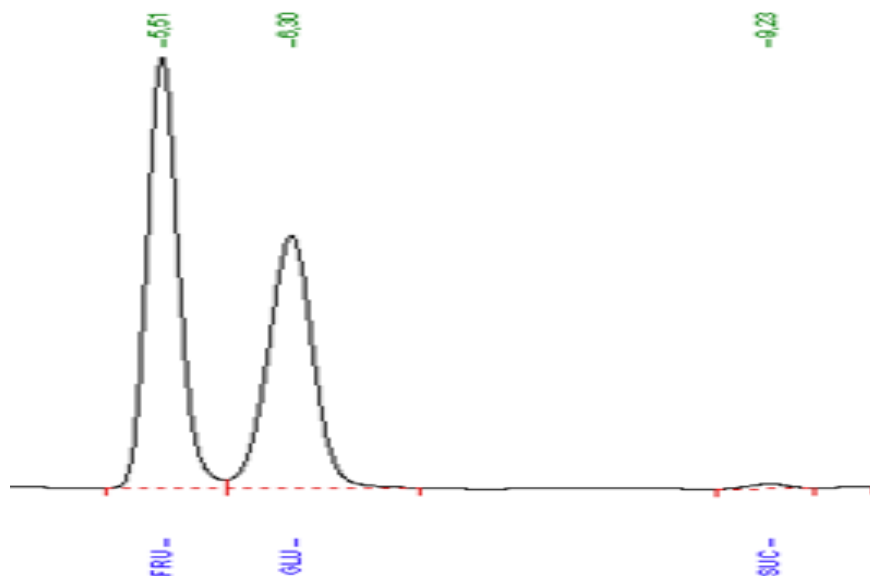
**Table.2** Sugar analyses of honey samples from Angola, (n=10)

Sample	Fructose, %	Glucose, %	Sucrose, %
1	37.00	30.00	0.50
2	29.60	22.50	0.50
3	34.90	30.30	0.80
4	37.40	26.60	0.50
5	36.20	30.80	0.50
6	38.60	31.40	0.50
7	36.20	31.70	2.13
8	35.90	31.10	3.96
9	38.90	31.10	0.50
10	40.10	31.10	2.37
Mean±SD	36.44±2.85	29.66±2.90	1.23±1.20

**Fig.1** Box plot diagram of proline. The minimum, maximum and median values are shown



**Fig.2** Chromatogram of the main sugars (fructose, glucose, sucrose) of the Angolan honey samples



The values found fell within the European legislation corresponding to a good degree of freshness for honey samples from country with tropical climate. All samples presented HMF levels below 80 mg/kg of honey.

The average value of HMF was also low. It can be concluded that the values obtained for HMF and diastase activity are typical for unprocessed honey from country with tropical climate. These two parameters do not relate to the origin of the samples (Anklam, 1998).

The results for the three main sugars are presented in Table 2. All honey samples present lower values of glucose and a bit higher levels of fructose. The contents of the main sugars (fructose, glucose, sucrose) and the sum of fructose and glucose are comprised in the established confidence intervals in almost all honey samples. Indeed, only one sample presents lower sum of fructose and glucose (52.10%). In the same manner, the sucrose content is less than 5% for all samples (European Commission, 2002). The maximum value observed is 3.96%.

HPLC chromatogram indicates that sugar composition in the tested honey samples is similar. However, some variations in the content of individual sugars are evident. Figure 2 shows the HPLC profile of one honey sample.

Fructose/glucose ratio (F/G) and glucose/water (G/W) ratio were also determined. The F/G ratio was between 1.14 – 1.41 and it indicates the ability of honey to crystallize. The honey crystallization is faster when F/G ratio is below 1.0 and it slows when this ratio is up to 1.0 (Draiaia *et al.*, 2015; El Sohaimy *et al.*, 2015). For all obtained samples F/G ratio is more than 1.0. Accordingly, G/W ratio was between 1.14 – 1.83. Honey crystallization is faster when that ratio is more than 2.0 (Amir *et al.*, 2010). Furthermore, honey crystallization can depend on other factors such as sucrose, maltose and insoluble substance (dextrin, colloids).

Having into account the results obtained in this study, the authors consider that all

analyzed multifloral honey samples from Angola indicate a good quality level. Special attention should be paid to the minimum value of diastase activity because some honey samples from tropical countries have much lower enzymatic activity. Much of the information hereby conveyed is completely new and with applications not only in the academic world but also in the practical life.

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