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Relationships between anthocyanins and other compounds and sensory acceptability of Hibiscus drinks

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ABSTRACT

Chemical composition of Hibiscus drinks (Koor and Vimto varieties, commercial and traditional, infusions and syrups) ($n = 8$) was related to sensory evaluation and acceptance. Significant correlations between chemical composition and sensory perception of drinks were found (*i.e.* anthocyanin content and Hibiscus taste) ($p < 0.05$). Consumers ($n = 160$) evaluated drink acceptability on a 9-point verbal hedonic scale. Three classes of behaviour were identified: (a) those who preferred syrup (43% of consumers); (b) those who preferred infusion (36%); and (c) those who preferred all of the samples (21%). Acceptability of 'syrup likers' was positively correlated to sweet taste, reducing sugar content and inversely correlated to acidic taste and titratable acidity ($p < 0.10$). Acceptability of 'infusion likers' was positively correlated to the taste of Hibiscus drink and anthocyanin content. The study showed that the distinctions between the acceptability groups are very clear with respect to the chemical composition and rating of sensory attributes.

1. Introduction

Hibiscus sabdariffa L. is an herbaceous plant that belongs to the family of Malvaceae (Cissé, 2011). It is an annual herb cultivated for its leaves, stem, seed and calices (Fasoyiro, Babalola, & Owosibo, 2005). *H. sabdariffa* has high antioxidant content related to the presence of anthocyanins with potent antioxidant activity (El Sherif, Khattab, Ghoname, Salem, & Radwan, 2011). The calyx of *H. sabdariffa* is of greatest interest because it is used for making a variety of products including infusions, food colourants and jam (Gonzalez-Palomares, Estarrón-Espinosa, Gómez-Leyva, & Andrade-González, 2009; El Sherif et al., 2011). The consumption of the drink is widespread in Africa and Asia. In Mali, Côte d'Ivoire and Burkina Faso, the drink is called 'dabileni'. In Egypt, it is known as the "drink of the Pharaohs." In Sudan the name is 'tea Karkade'. In Senegal, in particular, the drink, called Bissap, is very popular (Cissé, 2011). The most commonly consumed varieties of Hibiscus in Senegal are made from the local variety (also called Ordinary or Koor) and one of Sudanese origin (also called Vimto). The drink (called 'juice' in Senegal) is made from an extract or infusion obtained by aqueous extraction. The extraction is typically carried out between 25 °C (ambient temperature) and 100 °C (boiling temperature). After filtration, sugar and other ingredients, such as other artificial flavourings (*e.g.* banana, mint) may be added (Cissé, Vaillant, Kane, Ndiayea, & Dornier, 2011). The process for making syrup is similar; the difference being the amount of water and sugar added.

Consumer acceptance is important for product development or improvement, marketing and promotion strategies. Along with product development or improvement and economic viability, this will give food companies confidence to expand the adoption in Africa and adopt these products in other parts of the world. A number of authors have published on the hedonic acceptability of *H. sabdariffa* infusion in relation with the physico-chemical characteristics of the product (Bamishaiye, Olayemi, & Bamishaiye, 2011; Bolade, Oluwalana, & Ojo, 2009; D'Heureux–Calix & Badrie 2004; Fasoyiro et al., 2005; Gonzalez-Palomares et al., 2009; Mounigan & Badrie 2006; Mounigan & Badrie, 2007; Nwafor & Ikenebomeh 2009; Olayemi, Adedayo, Rukayyah, & Bamishaiye, 2011; Suliman, Ali, Eldeen, Idriss, & Abdualrahman, 2011). However, although

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consumer acceptance was measured using a 9-point hedonic scale for appearance taste and overall acceptance, these studies included a too few people (between 10 and 20 on average; and 50 for the study by D'Heureux–Calix & Badrie, 2004 and Mounigan & Badrie, 2006) that are not statistically valid. Hence there is a need for acceptance studies based on interviews of sufficient consumers (ISO 8587, 2006). At the exception of the study by Mounigan & Badrie, 2006 that related to Hibiscus wine, these research studies have not investigated the relationships between physico-chemical parameters, sensory evaluation and hedonic acceptance.

This study firstly explored the chemical composition of *H. sabdariffa* drinks and then examines the relationships to the sensory profile and acceptance. This will give a better understanding of the relationships and provide valuable information for developing new products that better meet consumer demand.

2. Materials and methods

2.1. Infusion and syrup samples tested

Hibiscus calices from two different varieties of calices (Sudanese and Ordinary) were harvested during the months of January–March 2011. The calices were purchased in Latmingue from Kaolack Region (central Senegal).

Eight different Hibiscus drinks (six infusions and two syrups representative of the consumption of Senegal) were initially tested by the panellists:

1. Commercial Sudanese infusion (CSi).
2. Commercial Sudanese syrup (CSs).
3. Commercial Ordinary infusion (COi).
4. Commercial Ordinary syrup (COs).
5. Commercial Mixed (Sudanese/Ordinary (50:50)) infusion (CMi).
6. Traditional boiled Ordinary infusion (TBOi).
7. Traditional ambient temperature Ordinary infusion (TAOi).
8. Traditional ambient temperature Sudanese infusion (TASi).

Commercial samples of infusions and syrups were manufactured by a local Senegalese fruit juice and syrup company that sells in supermarkets and restaurants in Senegal. Good hygiene and manufacturing practice were applied. Commercially made syrups and infusions were processed from the same batch of calices on a single day (9 am–1 pm) so that they were similar. Ratios of calyx/water (solid-to-solvent (kg kg^{-1})) were 1/20 and 1/4 for infusions and syrups respectively. In practice infusions were prepared with 80 kg of water added to 4 kg of calices and syrups with 40 kg of water added to 10 kg of calices. The process of preparation of commercial infusions and syrups differed mainly in terms of sugar concentration. In both cases calices were soaked in water at ambient temperature (25 °C) for 2 h. This aqueous extraction resulted in a bright red colour extract that was filtered. The liquid was then pasteurised using a cooking pot heated by a gas combustion skimmer. After pasteurisation the drink was cooled down under regular manual agitation.

In the preparation of infusions, sucrose (130 g L^{-1}) was added in the commercial infusions before pasteurization at 85 °C for 20 min. In the preparation of Commercial syrups, the liquid was pasteurised up to a maximum temperature of 105 °C and cooled down immediately. Sucrose (1300 g L^{-1}) was added after pasteurisation. Syrups and infusions were bottled in clear glass bottles as the product reached a temperature of 70 °C. Upon cooling to ambient temperature, infusions were stored in the fridge (between 4 and 8 °C) whilst syrups were stored at room temperature (25 °C).

Traditional samples were prepared by a local processor using traditional practices and applied good hygiene and manufacturing practice. In the traditional method, calices of Sudanese or Ordinary variety were either extracted with bottled water at ambient temperature during 2 h to produce either Traditional ambient temperature Sudanese infusion (TAOi) or Traditional ambient temperature Sudanese infusion (TASi), or boiled during 20 min to make Traditional boiled Ordinary infusion (TBOi). Sucrose (130 g L^{-1}) sugar was added and the filtrated infusion. There was no pasteurisation stage and consequently the drinks were made the day before sensory tests and stored at 4 °C.

The shelf life of the Commercial syrups and infusions is 1 year and 4 months, respectively. The shelf life of the Traditional infusions is 7 days (4 °C).

2.2. Physical and chemical analyses

All reagents used were of analytical grade and were purchased from Sigma (L'Isle d'Abeau, France). Titratable acidity, pH and dry matter were measured using standard methods (AOAC, 1990). In brief, total titratable acidity was determined with a TitroLine easy tritator (SCHOTT Instruments, Mainz, Germany), using 0.1 N NaOH solution. The pH value was determined using a calibrated pHmeter and dry matter was determined by drying a 5 g sample at 105 °C up to constant weight (24 h minimum). Total soluble solids (TSS) content was measured with an Abbe refractometer (Atago, Tokyo, Japan). Total anthocyanin content was assessed by the pH differential method at pH 1 and pH 4.5 (Lee, Durst, & Wrolstad, 2005). All absorbance readings were done against distilled water, which acted as the control. Spectrophotometric measurements were carried out using Specord 200 plus spectrophotometer (Analyik Jena AG, Germany). Concentrations were expressed as delphinidin-3-xylosylglucoside equivalents for Hibiscus (molecular weight = 577 g mol^{-1}). The molar extinction coefficient at pH 1 and 510 nm used for calculation was 26,000 L mol^{-1} cm^{-1}. The total phenolic content was determined with Folin–Ciocalteu reagent, according to the method optimised by George, Brat, Alter, and Amiot (2005) that used aqueous solution of sodium carbonate Na_2CO_3 (75 g L^{-1}), HPLC grade methanol, analytical grade acetone, gallic acid anhydrous solution at 5 mg/mL prepared the same day. Colour measurement was done on samples (30 ml) in glass Petri dishes, using a colorimeter HunterLab Konica Minolta Cr. 410 to measure the $L^*a^*b^*$ scale. The instrument was calibrated with a white tile. Total and reducing sugars were determined using the Luff–Schoorl method (European Economic Community, 1979). Solvents for total and reducing sugars were: cupro-alcaline solution, hydrochloric acid HCl (d = 1.18); sodium hydroxide (NaOH) solution at 33%; potassium iodine (KI), sulfuric acid solution (H_2SO_4) at 25% (d = 1.83–1.84); starch at 5 g L^{-1} in water; sodium thiosulfate 0.1 N and iodine solutions at 0.1 N. Samples were stored at −24 °C during 1 week prior to chemical and physical analyses. Samples were analysed in minimum triplicate for each type of analysis.

2.3. Ethics

This study has been assessed and approved by the University of Greenwich Research Ethics Committee. Consent was sought from sensory panellists and from adult consumers participating in this study. Samples were prepared according to good hygiene and manufacturing practices. Participants were informed about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point and that the responses would be anonymous. A consent form was signed.

2.4. Sensory evaluation

Hibiscus drinks (infusions and syrups) were scored by a semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided