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

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## Hibiscus drinks compounds & sensory acceptance

**Aurélie Bechoff [a,*], Mady Cissé [b], Geneviève Fliedel [c], Anne-Laure Declemy [c], Nicolas Ayessou [b], Noel Akissoe [d], Cheikh Touré [e], Ben Bennett [a], Manuela Pintado [f], Dominique Pallet [c] and Keith I. Tomlins [a]**

[a] *Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME7 3RU, United Kingdom*

[b] *Cheikh Anta Diop Université de Dakar, BP 5005, Dakar-Fann Sénégal*

[c] *CIRAD Montpellier, France TA B-95 / 16, 73 rue Jean-François Breton, 34398 Montpellier Cedex 5, France*

[d] *Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 01 BP 526 Cotonou, Bénin*

[e] *Association Afrique Agro Export, Sot Sotrac Mermoz – BP 45.028 Dakar Fann, Sénégal*

[f] *CBQF- Escola Superior de Biotecnologia. Rua Dr. António Bernardino de Almeida, 4200-072 Porto, Portugal.*

*Corresponding author: Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, United Kingdom. Tel: +44 (0)1634883071; Fax +44 (0)1634 88 3386. E-mail address: a.bechoff@gre.ac.uk

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## ABSTRACT

Chemical composition of Hibiscus drinks (Koor and Vimto varieties, commercial and traditional, infusions and syrups) 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). 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 titrable acidity. Acceptability of 'infusion likers' was positively correlated to the taste of Hibiscus drink and anthocyanin content. The study shows that the distinctions between the acceptability groups are very clear with respect to the chemical composition and rating of sensory attributes.

Keywords: *Hibiscus sabdariffa* L., roselle, cluster, sensory tasting, acceptability, syrup, infusion

## 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 calyces (Fasoyiro, Babalola, & Owosibo, 2005). *Hibiscus 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 *Hibiscus sabdariffa* is of greatest interest because it is used for making a variety of products including infusions, food colorants and jam (Gonzalez-Palomares *et al.* 2008; El Sherif *et al.* 2011). The consumption of the drink is widespread in Africa and Asia. 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 (*eg.* 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. Little data is available on export quantities of syrup, infusion and calices from Senegal (Cissé 2011). Exports of calyx are mainly to the United States and Europe, including, notably France and Germany (Guèye, 2005), which represent 80% of the European market that is estimated at 3000 tons per year. However the quantities currently exported are not sufficient to meet demand both locally and internationally.

Consumer acceptance is important for product development and marketing and promotion strategies. Along with product development and economic viability, this will give food companies confidence to adopt these products in other parts of the world and expand the adoption in Africa. A number of authors have published on the acceptability of *H. sabdariffa* infusion (Bamishaiye, Olayemi, & Bamishaiye, 2011; Bolade, Oluwalana, & Ojo, 2009; D'Heureux–Calix & Badrie 2004; Fasoyiro *et al.* 2005; Olayemi, Adedayo, Rukayyah, & Bamishaiye, 2011; Gonzalez-Palomares *et al.* 2009; Mounigan & Badrie 2006; Mounigan & Badrie 2007; Nwafor & Ikenebomeh 2009; Suliman, Ali, Eldeen, Idriss, & Abdualrahman, 2011). However, although 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) that are not statistically valid. Hence there is a need for acceptance studies based on interviews of sufficient consumers (ISO 8587).

This study firstly explored the chemical composition of *Hibiscus sabdariffa* drinks and then examines the relationships to the sensory profile and acceptance. This will give a better understand 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*

Nine different Hibiscus samples (six infusions and three syrups) were initially tested by the panellists. Infusions were tested directly whilst syrups were diluted 1:4 with potable water before consumption.

The Hibiscus drink samples were from two different varieties; Sudanese or Vimto variety (originally imported from Sudan) and Ordinary or Koor variety (Senegalese variety). Selection of samples for sensory analysis was based on the representatively consumption in Senegal and were the following:

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. Commercial Mixed (Sudanese/Ordinary (50:50)) syrup (CMs)
7. Traditional boiled Ordinary infusion (TBOi)
8. Traditional ambient temperature Ordinary infusion (TAOi)
9. 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 so that they were similar. The process of preparation of commercial infusions and syrups differed mainly in terms of sugar addition. In both cases the first stage was an aqueous extraction at ambient temperature (25ºC for 2 h). Sucrose (130 g/L) was added in the commercial infusions, after filtration (to separate calyces from aqueous extract) and before pasteurization at 85 °C for 20 minutes. Sucrose (1300 g/L) was added in the commercial syrups after filtration followed by a thermal treatment, which consist in heating the product up to a maximum temperature of 105 °C and cooling down the product immediately afterwards.

Traditional samples were prepared by a local processor using traditional practices and applied good hygiene and manufacturing practice. Calices for the traditional infusion were bought from the market. In the traditional method, calyces were either extracted at ambient temperature (2 hours) or boiled (20 minutes). Sucrose (130g/L) sugar was added and the mixture filtrated. There was no pasteurisation stage in the traditional preparation. In absence of heat treatment, preparation of the traditional drink was made using bottled water in accordance with good hygiene practices. The product is made on the day before sensory tests and stored at 4 ° C.

The shelf life of the commercially manufactured syrup and infusions (stored at 4 ºC) is one year and four months respectively. The shelf life of the traditional samples (without pasteurisation) is 7 days (4 °C).

### 2.2 Physical and chemical analyses

Titratable acidity, pH and dry matter were measured using standard methods (AOAC, 1990). Total soluble solids (TSS) content was measured with an Abbe refractometer (Atago, Tokyo, Japan). Total anthocyanin content was assessed by the pH differential method (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 optimized by George, Brat, Alter, & Amiot (2005). All reagents used were of analytical grade and were purchased from Sigma (L'Isle d'Abeau, France). Colour measurement was done samples (30ml) 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.

### 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 practice. 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 (Meilgaard, Civile, & Carr, 2007; Tomlins, Owori, Bechoff, Menya, & Westby, 2012). The panel was composed of university technicians, students or private company employees (17 people in total). Sessions were conducted at Cheikh Anta Diop University of Dakar (Senegal) in air conditioned room with controlled lighting and ambient temperature (22 to 25$^{o}$C). The language used for the sensory testing was French. The panellists had been screened for familiarity with the product. Sensory attributes were generated during a preliminary focus group session guided by the panel leader. A total of 11 sensory attributes were developed for the drink for which the group of panellists had a consensus. Sensory attributes generated were as follows (English translation):

- Red colour – colour characteristic of red Hibiscus
- Clarity – drink you can see through
- Concentration aspect – like a syrup that can be diluted or concentrated
- Hibiscus odour – odour characteristic of Hibiscus

- Fermented odour – alcoholic odour indicating a fermentation and that the product quality is deteriorating
- Acidic taste – taste characteristic of lemons
- Sweet taste – taste like sugar
- Hibiscus taste – taste characteristic of Hibiscus
- Bitter taste –taste characteristic of coffee
- Irritant – that has a foreign and piquant taste on the tongue
- Fermented taste - alcoholic taste indicating a fermentation and that the product quality is deteriorating

After a period of training using these attributes, the nine Hibiscus samples were tested blind in triplicate by the panel and the order in which they were presented was random. At each session, four Hibiscus sample drinks (coded with 3-figure random numbers) were served in transparent plastic cups in random order to each panellist. Hibiscus drinks (infusions and syrups) (50 ml) were tested by the panellists. Infusions were stored in the fridge overnight. Intensity for the sensory attributes was scored on a 100 mm unstructured scale, anchored with the terms ‘not very’ at the low end and ‘very’ at the high end.

### *2.5 Consumer acceptability*

Consumers (160) were interviewed at five different locations in Dakar using the central location method (Meilgaard *et al.*, 2007). These were the following: Veterinary faculty (n=33); French cultural centre (n=72); Terou Bi (Beach) (n=36), Guediawaye (n=9), and Pikine (n=10) areas. Consumers were from African (mainly resident Senegalese) or from European origin (tourists or residents).

Four commercial Hibiscus drinks were selected for consumer tasting among the samples used for sensory tasting as followed:

- Commercial Sudanese syrup,
- Commercial Ordinary infusion,
- Commercial Ordinary syrup,
- Commercial Mixed (Sudanese/Ordinary (50:50)) infusion.

During acceptability testing, each consumer was invited to taste each Hibiscus drink (50 ml) (presented in random order and coded with three figure random numbers). Consumers were asked to score the acceptability with respect to appearance, taste and overall liking using a nine-point verbal hedonic box scale which varied from dislike extremely to like extremely (Meilgaard *et al.* 2007). Syrups were diluted with potable water (1:4). All sample drinks were transported in cool boxes with ice.

Along with obtaining information about the acceptability of the Hibiscus drinks, information was elicited from each consumer regarding demographics, education, Hibiscus consumption and buying. All spoken interviews were conducted in French or in the local language (Wolof) and the score sheets and questionnaires were written in French. Trained enumerators assisted the consumers when required. The interview procedure (acceptability and the questionnaire) lasted no more than 30 min.

### *2.6. Statistical Analysis*

Analysis of variance (mixed effect model), correlation analysis (Pearson), Chi-squared analysis and principal component analysis (correlation matrix) were carried out using SPSS (V 20.0) or XLSTAT (V 5.2, Addinsoft). Hierarchical cluster analysis (Wards method) was used to segment the consumers interviewed at the different locations into three different groups. Segmentation gives a more complex variation in acceptability among the consumers and is helpful to understand differences in consumer behaviour. Multiple pairwise comparisons were undertaken using the Tukey test with a confidence interval of 95%.

## **3. Results and Discussion**

### *3.1. Description of chemical composition of Hibiscus drinks*

Chemical analyses of nine Hibiscus drinks are reported in Table 1. The pH value was in accordance with previous studies on Hibiscus (Gonzalez-Palomares *et al.* 2009; Bamishaiye *et al.* 2011; Olayemi *et al.* 2011; Ramirez-Rodrigues, Plaza, Azeredo, Balaban, Marshall, 2012). The pH value was very similar for all the samples ranging from 2.48 in CMi to 2.76 in TASi.

Total sugar and reducing sugar contents were greater in syrups compared to infusions: this was a result of adding sugar to the syrups. Traditional infusions (TBOi; TAOi and TASi) had low reducing sugars compared to the other samples. These low levels of reducing sugars could be attributed to the lack of thermal treatment Since during heating some disaccharides such as sucrose can be reduced into monosaccharides such as glucose and fructose, which are reducing sugars.

In all infusions apart from the traditional boiled infusion (TBOi), titratable acidity, concentration in anthocyanins and in polyphenols was higher than in syrups. An explanation could be that syrups were more diluted (with water) than infusions and therefore the anthocyanin level was diluted in syrups. Moreover, harsher pasteurisation for syrups could have resulted in greater degradation of organic acids and polyphenols including anthocyanins in syrups. The lower anthocyanin and polyphenol contents in TBOi may have resulted from over-boiling of the sample. According to Cissé, Vaillant, Acosta, Dhuique-Mayer, & Dornier, (2009), anthocyanins are affected by temperature and describe a first order kinetic degradation (Arrhenius model). Ramirez-Rodrigues *et al.* (2012) showed that type of process and storage had a significant effect on anthocyanin degradation.

Other reported levels of anthocyanin contents varied. For example, anthocyanin content in Hibiscus drinks was lower in the study by Wong, Yusof, Ghazali, & Che Man, (2003) but higher in the studies by Cissé *et al.* (2009 and 2011) compared to this study. Differences in anthocyanin content and titrable acidity in these different studies might result of cultivar differences and seasonal variations. Cissé *et al.* (2009) reported that there were great differences among cultivars in anthocyanin content and titrable acidity. As an example, varieties of Koor, Vimto and Thai presented levels of anthocyanins of 250, 718 and 360 mg/L respectively (Cissé *et al.* 2009). Ramirez-Working with a Mexican variety of *Hibiscus sabdariffa* L., Ramirez-Rodrigues *et al.* (2012) reported levels of anthocyanin much lower of around 50 mg/L.

Organic acids such as ascorbic acid are known to be more labile than anthocyanins (Torres, Tiwari, Patras, Cullen, Brunton, & O'Donnell, 2011). Whilst commercial infusions had similar anthocyanin levels to the traditional infusions, their titrable acidity was greater (TAOi and TASi). It is speculated that either organic acids might have been either lost during preparation or storage of traditional infusions or the batch used for traditional processing was naturally less rich in organic acids.

Regarding the measurement of colour, L*a*b* values were similar to those reported by Wong *et al.* (2003) working on roselle infusion. L* (brightness) a* (red colour) and b* (yellow colour) values tended to be greater for syrup drink as compared with infusion. Therefore syrups tended to have brighter colours than infusions. Infusions were of darker colour and more blue-purple.

Total soluble solids (TSS) contents reported by Wong *et al.* (2003) were excessively lower (0.6g/kg) than the values reported in our study. Yet the TSS reported by Cissé *et al.* (2009; 2011) were much greater than the values in the present study. The differences in TSS in different research works on Hibiscus might be explained by the different amount of sugar added to the drinks.

Chemical analysis showed that there are significant differences in the values reported for Hibiscus drinks. These variations are probably the result of processing conditions (syrup or infusion) but also the result of varietal differences between the calices (Koor or Vimto).

*3.2. Sensory profile of Hibiscus drinks*

The sensory attributes of the eight Hibiscus drinks tested were significantly different (Table 2) with respect to sample (linear mixed model; ANOVA; $P<0.05$) for all the sensory attributes (red colour; clarity; concentration; Hibiscus odour and taste; acidic, sweet, bitter, irritant and fermented taste) but for fermented odour. Fermented odour was more difficult to differentiate among the panellists possibly because discriminating between odours that are not very intense can be proved challenging.

Sample panellist interactions for some of the attributes are probably because it was not possible to provide standards and because the panel was semi-trained and some attributes were more difficult to assess.

The sample that were the most red in colour were CMi and CSi ($p<0.05$). The ordinary infusion (COi) and syrup (COs) were scored less in terms of colour. The darker Sudanese Hibiscus is redder in colour and this result was expected. Wong *et al.* (2003) evaluated the sensory attributes of *H. sabdariffa* calixes submitted to different processes (cold or hot; with or without a press) to prepare the infusion. The infusion was evaluated by a sensory panel who scored colour (redness), odour (grassiness) and taste (grassiness, sourness, sharpness) using a scale of 100 mm. The redness attribute varied according to the method of pressing (screw press) and extraction (hot water extraction). In this work, the redness of the Hibiscus drink also varied according to the method of processing (infusion or syrup) or extraction (cold or hot).

Syrups were perceived significantly sweeter than infusions ($p<0.05$) and this is in accordance with the way these products are prepared. Syrups (even after dilution) contained more sugar.

In terms of Hibiscus aroma (taste) the infusions were scored significantly higher than the syrups. The Sudanese and Mixed infusions (CSi and CMi) were scored having significantly greater Hibiscus taste than the Ordinary one (COi). The acidic taste was greater for the Traditional Ordinary variety (TAOi) compared to Sudanese variety (TASi). According to the Senegalese customs, the ordinary variety (Koor) is supposed to be more acidic and flavoured than the Sudanese (Vimto) one. It is a habit for some people to mix both types in order to obtain both aroma and redder colour. Cissé *et al.* (2009) have shown that the Koor calices have higher acidity levels than that the Vimto calices that has a higher anthocyanin content and this is in accordance with our study although the difference in acidic taste among the commercial sample infusions (CSi and COi) was not perceived by the panelists.

*3.3. Correlations between sensory attributes and chemical analyses of Hibiscus drinks*

The sensory perception of the Hibiscus drinks was clearly related to chemical composition (Table 3). Clarity was significantly correlated to total soluble solids (TSS), dry matter and reducing sugar content ($p<0.05$).

Surprisingly there were no correlations between red colour as perceived by the panel and L*a*b* values. Hence the perception of colour might be linked to other attributes for panellists.

Acidic taste was positively correlated with titrable acidity and negatively with total sugars and a* value (measuring the red colour). This can be explained by infusions being more acidic, less sweet and less red in colour compared to syrups. Negative correlation of sweet taste to titrable acidity and positive correlation to total sugars and b* colour (yellow) also means that addition of sugar would mask the acidity of the drinks perceived by the panellists. Similarly Lawless, Threlfall, Howard, & Meullenet (2012) working on mixed drinks of blueberry and blackberry infusions and grape concentrates reported that sweetness was inversely correlated to titrable acidity.

Hibiscus taste, which is an important characteristic of the Hibiscus drink, was significantly correlated with anthocyanin content. This confirms that the presence of anthocyanins is perceptible by the panellists and linked to the characteristic taste of Hibiscus. In addition, the concentration in polyphenols was significantly correlated to bitter taste and this was in accordance with Jaeger, Axten, Wohlers, & Sun-Waterhouse (2009) and Lawless *et al.* (2012). Jaeger *et al.* (2009) reported bitter taste as being characteristic of polyphenol-rich beverages. also reported that bitter taste was associated with total phenolic content in berry juices The bitter taste was significantly more pronounced in infusions compared to syrups ($p<0.05$) (Table 1). Interestingly, Hibiscus and bitter taste were negatively associated with total sugars, which suggest that addition of sugar would be masking the Hibiscus and bitter tastes.

*3.4. Consumer testing*

*3.4.1. Consumer acceptance of Hibiscus drinks*

Overall, the acceptance of the Hibiscus drinks significantly differed between the four samples at $p<0.01$ (One-way ANOVA). All of the drinks were on average acceptable since the mean scores were greater than a score of 5 (neither like nor dislike). The most liked was the Commercial Mixed infusion (CMi =6.2±0.1) (average±standard deviation) followed by the Commercial Sudanese Syrup (CSs =5.9±0.1), the Commercial Ordinary Syrup (Cos =5.6±0.2) and the Commercial Ordinary infusion (COi =5.2±0.2). The average liking was 5.7 over the four samples. As a comparison, Jaeger *et al.* (2009) reported that the acceptance of consumers for polyphenol-rich beverages made out of berries and chocolate mixed or single varied between 2.3 and 5.1. Lawless *et al.* (2012) indicated that the consumer overall liking of blackberry and blueberry juices was 2.9 and 5.5 respectively. Hence Hibiscus drink as a polyphenol-rich beverage would be rated higher. However, acceptance differs by product and by type of consumer.

*3.4.2 Segmentation of consumers into groups of similar acceptance patterns regarding the Hibiscus drinks*

Hierarchical cluster analysis (Wards Method) indicated three different groups of consumer profile with respect to the Hibiscus drinks. The mean liking for each of the four groups is illustrated in Fig. 1. We used a score of five 'neither like nor dislike' as an indicator of "neutral attitude". The products rated below five were considered as "disliked" and above five as "liked". For the purposes of cluster division, the groups were grouped as 'syrup likers' (43%), 'infusion likers' (36%) and 'indifferent likers' (21%).

Demographic differences and consumer attitudes to Hibiscus with respect to cluster division are found in Table 4.

The three clusters did not significantly differ in terms of sociological criteria such as age, sex, residency, education level, marital status etc. There were no differences in the form consumers from the different clusters purchase Hibiscus: the most common form of buying was as calices followed by infusion (in sachets), infusion in recycled bottles, industrial infusion and syrup. Percentage consumption of Hibiscus natural or with added artificial flavour (*eg.* banana, strawberry, pineapple and mint) was also the same for the three clusters. Most consumers preferred the natural product (66%) compared, to the one with added flavour (34%).

In each of the three clusters frequency of consumption of Hibiscus was quite high (above 60% of people interviewed consume it at least once a week) and shows that Hibiscus is a popular drink in Senegal. There were however differences between the clusters in the frequency of consumption: 'syrup likers' tended to consume Hibiscus drinks less frequently than the 'infusion likers' and 'indifferent likers' (62%, 79% and 80% respectively). Specific taste for Hibiscus might explain more frequent consumption in the two latter clusters.

*3.5. Correlations between sensory attributes, chemical analyses and consumer acceptance*

Correlations between consumer acceptance, chemical analyses and the sensory attributes were explored (Table 5).

For the consumer group as a whole, their mean acceptance scores were not significantly correlated to any of the sensory attributes or concentrations of chemical compounds. This was to expect because consumers have diverse preferences.

There were significant relationships regarding the different consumer groups. Significant positive correlations ($p<0.10$) were identified between acceptability of 'syrup likers' and sweet taste and for reducing sugars and a* value. Negative correlations were found between the acceptability of 'syrup likers', acidic taste and titrable acidity, bitter taste and irritant taste.

Significant positive correlations ($p<0.10$) were identified between acceptability of the 'infusion likers' and red colour, concentration, Hibiscus odour, taste, and anthocyanins ($p<0.05$), polyphenols ($p<0.10$). Correlations was found between acceptability of 'infusion likers' and b* value (blue colour characteristic of anthocyanins).

There were no significant correlations ($p<0.10$) between the 'indifferent likers' and chemical analyses. However there were significant correlations between the acceptability of ‘indifferent likers’ and sensory attributes such as clarity. ‘Indifferent likers’ acceptability was also negatively correlated to fermented odour and taste. The absence of correlations between the ‘indifferent likers’ and chemical constituents was expected because ‘indifferent likers’ did not have any marked preference.

A significant correlation with the sensory attributes for these clusters support the finding that the acceptance was related to sensory attributes and consumers had selective tastes according the products they like most.

In summary, these correlations accord with the sensory perception of the samples and highlight that sweetness and sugar addition is an important criterion of acceptability for ‘syrup likers’ and Hibiscus taste or anthocyanin content would be an important criterion of acceptability for ‘infusion likers’.

Lawless *et al.* (2012) indicated that drivers in consumer acceptability of berry juice were sweetness and grape taste. Bitterness was a detractor of overall liking and therefore polyphenol content rich products were less acceptable (Lawless *et al.* 2012). However, this research did not attempt to classify consumers into different acceptance profiles. Our study showed that acceptability of ‘syrup likers’ was affected by bitter taste whilst that of the ‘infusion likers’ was not. Cluster analysis is useful to help find the “niche” consumers who have specific tastes that could drive the market for specific products. This present research is new because we report on relations between acceptance and chemical constituents.

### *3.6. Implications for adapting chemical composition of Hibiscus drinks*

Cluster analysis approach has been commonly used in consumer acceptance in order to determine which groups of people who would prefer which type of product. This approach is very useful in the marketing approach because it helps target specific consumers with the type of product they like. The liking can be depended upon many factors (socio-economic background; food customs) and knowing the consumers would help predict the product that they are more likely to adopt when launching a new product on the market for instance. In the case of this study involving *Hibiscus Sabdariffa* drinks, acceptability study will help re-engineering of the product that shall suit the consumer taste.

The sensory and chemical characteristics important to each group of consumers differed. For the indifferent likers who represented 21% of consumers, they were the least discerning consumers but liked all of the products. Their acceptance did not correlated with any specific chemical constituent measured in this research but did relate to specific sensory attributes (clarity, fermented odour and taste). The syrup likers (43% of consumers) were more discerning and their acceptance was related to the chemical constituents such as titrable acidity and colour as measured by a colorimeter. Their acceptance was specifically related to sensory attributes such as sweetness, red colour and non-irritant characteristics (low bitter or acidic taste). The infusion likers (36% of consumers) were also the most discerning consumers and their acceptance was related to different chemical constituents being anthocyanin and polyphenol contents and also to different specific sensory attributes being concentration, Hibiscus odour and Hibiscus taste.

## 4. Conclusions

The results of this research help to provide a basis of understanding how the chemical constituents of *Hibiscus sabdariffa* drinks relate to their sensory profile and acceptance. This research suggests that a range of chemical constituents correlated with the sensory attributes (appearance, odour and taste) and can help with product development and improvement since the chemical constituents also will relate to the different acceptance profile of the consumer. This knowledge could help formulation of products adapted to specific consumer tastes and will have implications for marketing strategies for example.


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