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Executive summary

This deliverable reports on the sensory evaluation of reengineered bissap and baobab.

Considering bissap and baobab these reengineered products had different sensory properties which indicate differing consumer perceptions which may or may not improve market penetration in Africa and EU. The re-engineering of the bissap drinks was conducted with the main objectives of improving the eco-efficiency of the production process, the preservation of nutritional quality and colour of the products, while diminishing the production costs. The sensory results confirmed that the new processing of UVc bissap resulting in a beneficial softening of some of the strongest attributes present in traditional infusion, such as bitterness, acidity and astringency, while the reengineered infusion, traditionally a well appreciated drink among Senegalese consumers maintained most of the sensory characteristics of the traditional product. In the case of baobab, the reengineered juices had different sensory characteristics to syrups. The attribute that was more distinguished for all samples it was sweetness.

In the case of Jaabi, this was not tested by a sensory panel. This is because the reengineered Jaabi product had inferior properties to the baseline one and hence would not have a viable market.

Detailed report for Bissap

Authors: Maria João Monteiro, Ana Pintado, Mady Cisse and Manuela Pintado

Bissap Summary

The sensory perceptions of new reengineered products included four bissap products also tested in Senegal for consumer perception (traditional infusion [baseline] and three reengineered Hibiscus (50% Kor and 50% Vinto) drinks – an infusion, a syrup and a vacuum-concentrate. Standard bissap and reengineered bissap and were analysed by descriptive analysis performed using Flash Profile Method. The Under-Vacuum concentrate (UVc), was characterized by strong hibiscus flavour, strong colour with medium acidity, astringency, bitterness and strongest honey compared to the other evaluated drinks. The Re-Engineered Syrup (REs) was characterized by sweeter product with a fruity and hibiscus aroma and with a lighter colour, lower acidity, bitterness and astringency than the other drinks. The infusions, traditional (CTi) and Re-Engineered (REi) showed to have similar profiles characterized by higher bitterness, acidity and astringency than the other drinks and lower sweetness. These results confirmed that the new processing in reengineered product REs and UVc allowed to softening positively some of the strongest attributes present in traditional infusion, such as bitterness, acidity and astringency, but the new reengineered infusion maintained similar sensory profile to the traditional. However, it is important to highlight that main target of reengineering was to improve nutritional value and stability under storage rather sensory improvement, but yet there was a positive impact for RE and UVc.

Bissap Background

Bissap is a non-alcoholic drink commonly consumed in African countries, particularly in Senegal. It is made from Hibiscus sabdariffa L. - an herbaceous plant belonging to the Malvaceae, most often from its Ordinary/Kor (Senegal) and/or Vimto (Sudan) varieties. The swollen calyxes, red colour and cup-like, are the part of the plant of commercial interest as they are rich sources of vitamin C, phytochemicals, and are also used for making a variety of products including, infusions, food colorants, jam and particularly of drinks (Sherif et al. 2011).

Previous AFTER studies on the acceptability of traditional hibiscus drinks by Senegalese and European consumers' uncovered significant effects of plant variety and processing method, highlighting the importance of harmonizing the sensory profile of these drinks as part of the product re-engineering process and improving the product acceptability for Senegalese and European consumers.

In view of this, three new hibiscus (50% Kor and 50% Vinto) drinks – an infusion, a syrup and a vacuum-concentrate were developed under AFTER project scope. These drinks were developed at the *Laboratoire de Formation Continue en Industrie Agroalimentaire* of the *Ecole Supérieure Polytechnique* of *Univeersité Cheikh Anta Diop* (UCAD), in Dakar. Their manufacturing process was subsequently tested and scaled-up in the pilot plant of *Centre Sectoriel de Formation Professionnelle aux Métiers des Industries Agroalimentaires (CSFP IAA),* also in Dakar. The new drinks were prepared following an eco-efficient process, design to improve the preservation of nutritional quality and colour of the products while diminishing the production costs, by maximizing hibiscus calyx extraction efficiency and diminishing pasteurization temperature and production time.

The present report describes the procedure and results of descriptive analysis performed on four hibiscus drinks using Flash Profile Method. The evaluated drinks encompass a traditional infusion

(baseline) and three new Hibiscus (50% Kor and 50% Vinto) drinks – an infusion, a syrup and a vacuum-concentrate developed by AFTER researchers.

Bissap Methodology

Ethical assessment and consent
The study was reviewed by project AFTER's Ethics Committee. Participants were informed about the study's general aim and procedures for handling personal data, and gave written informed consent prior to participating in the tasting sessions. All tested samples were produced and prepared according to good hygiene and manufacturing practices, so no safety or health concerns were hence introduced during processing.

Samples and preparation
The four hibiscus drinks tested were produced from dried calyces of the local 'Koor' and the Sudanese 'Vimto' H. var. sabdariffa cultivars (50:50), purchased at Latmingue – Kaolack.
The traditional infusion (CTi) was manufactured by a local Senegalese company. To this end, the dried calyces were soaked in water – ratio of calyces/water 1/20 (w/v) - at ambient temperature for 2 hours. The resulting extract was filtered, sweetened with sucrose (130 gL-1, up to 14-16 °Bx) and subsequently pasteurised at 90-95 ºC, 20-25 minutes.
The three new hibiscus drinks were produced in the CSFIAA pilot plant. The improved infusion (REi) was obtained from a ratio of ground calyces/water 1/40 (w/v) and sweetened with sucrose (150 gL-1, up to 16-18 ºBx). The Re-Engineered syrup (REs) was obtained employing an eco-efficient process. A ratio of 1/10 dried Hibiscus calices/water and 30 min extraction time at ambient temperature was used. The resulting infusion was filtered at 0.45 µm and pasteurized at 75ºC during 30 min. An addition of sucrose of 1.2 kg/L (until approximately 65-70°Brix) was used as in the traditional process. Syrup was cooled down immediately after pasteurization and was bottled as the product reached a temperature of 70°C. Syrup was stored at room temperature.
Lastly, the under-vacuum concentrate (UVc) was obtained using a ratio of ground calyces/water 1/5 (w/v) and 30 min extraction time at ambient temperature. The resulting infusion was filtered at 0.45 µm and pasteurized at 75 ºC during 30 min. The extract was subsequently evaporated under-vacuum at 75 °C and remained unsweetened. Upon cooling to ambient temperature, the concentrate was stored at 4 to 8 °C.
The REs sample was diluted 4 times with potable water prior to tasting. The UVc concentrate was diluted 40 times with potable water and sweetened with sucrose (130 gL-1). CTi and REi required no preparation.


Figure 1- Hibiscus drinks

Test facilities

Sensory sessions took place in the laboratory of sensory evaluation of the Escola Superior de Biotecnologia – Universidade Católica Portuguesa. These facilities comply with the requirements of ISO 8589 (ISO, 2007) and comprise a training room, dedicated kitchen and sensory booths with computerized data collection.

Figure 2 – Laboratory of sensory evaluation of the Escola Superior de Biotecnologia – Universidade Católica Portuguesa

Sensory evaluation

The descriptive analysis was performed using the Flash Profile Method (FP).
Flash Profile method was suggested by Dairou and Sieffermann (2002) for sensory description of food products according to their most salient sensory attributes and it has been applied to describe many different foods including fruit products and beverages since then.

Panellists

Twenty eight panellists were recruited and selected in compliance with ISO Standard 8586:2012 (ISO, 2012a), followed by 3-month training period on sensory evaluation, focussed on language development, improvement of discriminating ability, memorization and rating intensities of selected attributes.
The sensory panel was composed by eleven assessors.

Figure 3 – Sensory panel in a sensory evaluation of bissap.

Sensory attributes and tasting sessions

Preliminary selection of sensory descriptors was based on previous descriptive analysis of Bissap drinks held within the project After (Franco et al.; Tomlins et al.), deliverable QDA BISSAP. Nine sensory attributes were considered, being grouped by appearance (colour intensity), odour [hibiscus, fruity (cranberry/aronia), honey] and flavour (hibiscus, acid, sweet, bitter and astringent). Two tasting sessions were held on October 2014 in which the panellists ranked the intensity of their chosen set of descriptors. Qualtrics online survey software (Qualtrics, LLC.) was used for data collection.

Statistical Analysis

XLSTAT software (Addinsoft SARL, France) was used to carry out the statistical analyses. A Generalised Procrustes Analysis (GPA) was used to obtain the product's and attributes' configurations (Gower, 1975). GPA reduces the scale usage effects by detecting and minimization individual differences (Næs et al., 2010) (Hernández-Carrión, Varela, Hernando, Fiszman, & Quiles).

Bissap Results and discussion

Figure 4 shows the representation of hibiscus drinks and sensory attributes evaluated according the two dimensions of a GPA analysis, using the set of descriptors developed. The first two dimensions of GPA biplot explained 90.5% of the variability, and allowed a good differentiation among hibiscus drinks. It shows the closeness between the two infusions tested (CTi and REi) and the dissimilarity with the UVc and REs.

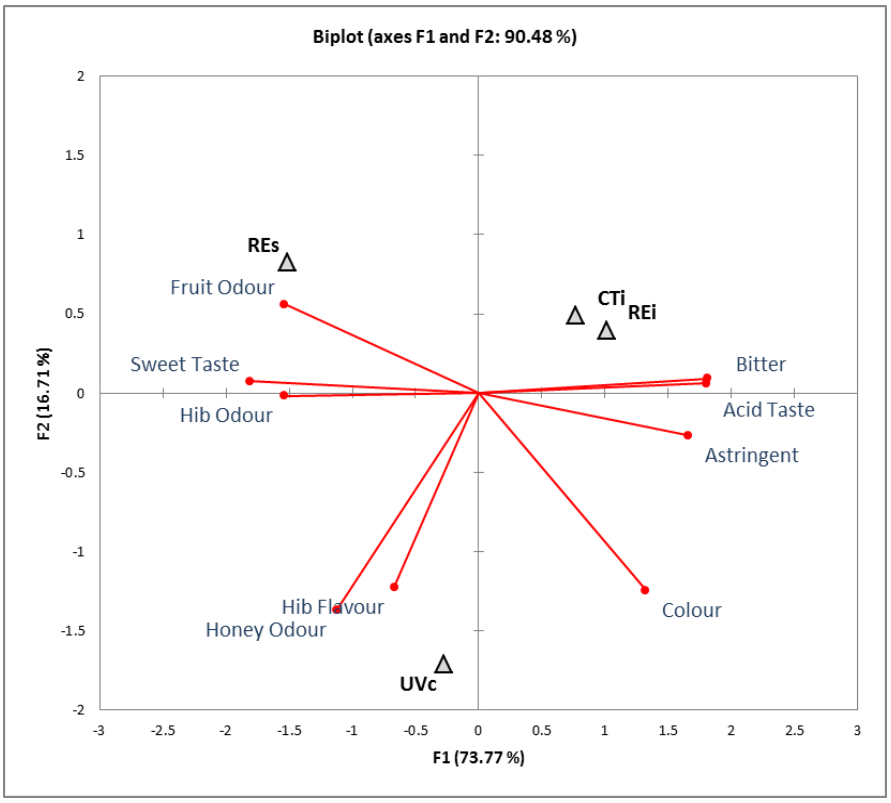

Figure 4 - Representation of the hibiscus drinks and sensory attributes evaluated in the two dimensions of a GPA analysis, performed. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion; Int=overall intensity; Hib=hibiscus.

The analysis shows that UVc was characterized by strong hibiscus flavour, strong colour with medium acidity, astringency and bitterness. The honey like odour was also stronger for the UVc than for the other evaluated drinks. Concerning the Re-Engineered Syrup (REs) the attributes were positioned oppositely showing to be the sweeter product with a fruity and hibiscus aroma and with a lighter colour, lower acidity, bitterness and astringency than the other drinks. The infusions, traditional (CTi) and Re-Engineered (REi) showed to have similar profiles characterized by higher bitterness, acidity and astringency than the other drinks and lower sweetness.

The obtained FP results complement the ones obtained using Senegalese consumer's descriptive profile for the same drinks using CATA method, reported in deliverable 5.5.2.3 and depicted in figure 4.
In fact the results obtained by both methods are comparable and it can be observed the good agreement between CATA and FP for most of the common and related descriptors used. The strong hibiscus (Bissap) character described by the consumers for the Re-engineered infusion (REi) in CATA method was an exception since it is not apparent in the FP and led to a wider differentiation between REi and the CTi. This apparent discrepancy may be due to the fact that the traditional hibiscus infusions in Senegal are more often prepared with Hibiscus of the local Koor Variety, characterized by its high acidity, bitterness and astringency, characteristics associated to a strong hibiscus character to local consumers.
Unlike FP, which uses only non-hedonic related descriptors, CATA uses sensory, emotional and hedonic related descriptors. The first two dimensions of the Correspondence Analysis (CA) performed on discriminating CATA terms explained 96.7%. In CATA CA plot UVc was located opposite to CTi. REi and REs, were also oppositely located. UVc was related with the descriptors: balanced taste, good taste, sweet, dark red, appealing, natural, refreshing and stimulating/energizing, whereas CTi was related with the descriptors: bitter, sharp odour and acid. REs in the CA plot was related to descriptors: light bissap, diluted, syrup taste, sweet, light red and refreshing. Oppositely located REi was described by terms such as strong in bissap, dark red, astringent, acid and stimulating/energizing.

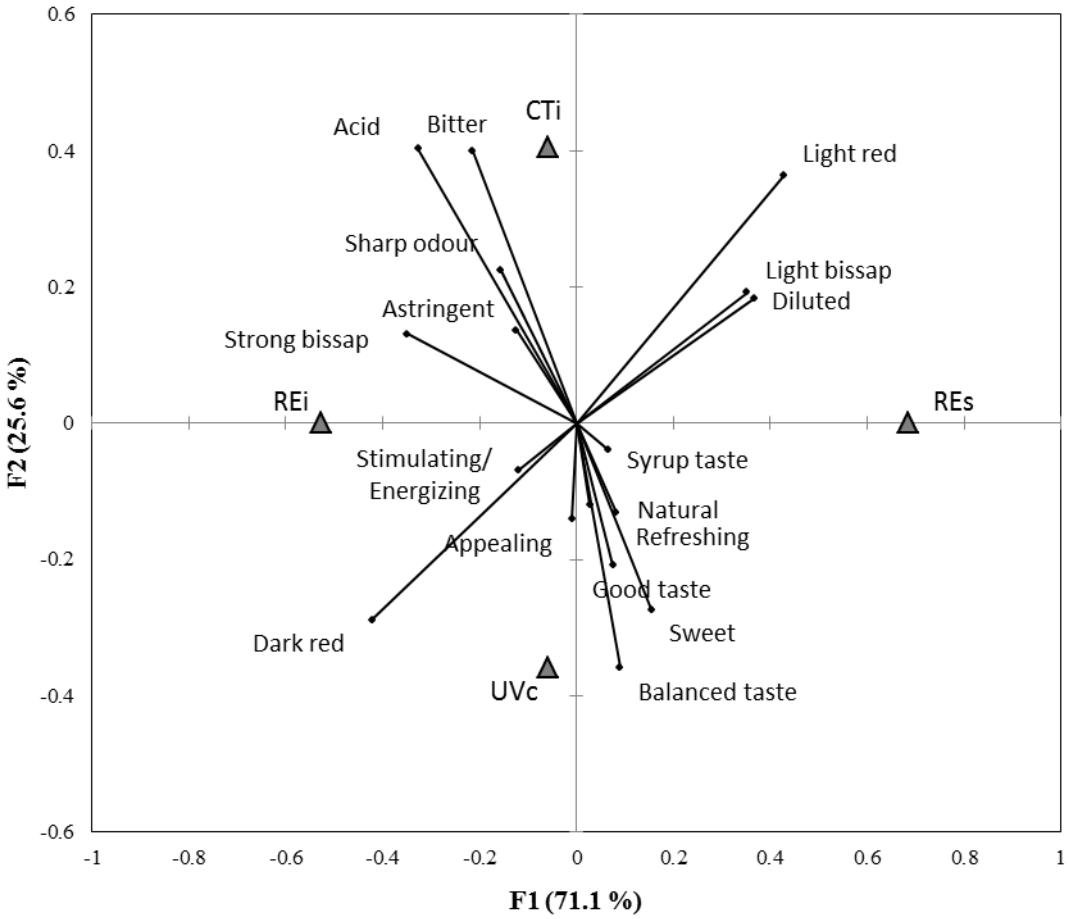

Figure 5 - Representation of the hibiscus drinks and CATA descriptors in the first two dimensions of a correspondence analysis. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

Bissap Conclusion

The re-engineering of the drinks was conducted with the main objectives of improving the eco-efficiency of the production process, the preservation of nutritional quality and colour of the products, while diminishing the production costs. These sensory results confirmed that the new processing of UVc allowed to softening positively some of the strongest attributes present in traditional infusion, such as bitterness, acidity and astringency, while the reengineered infusion, traditionally a well appreciated drink among Senegalese consumers maintained most of the sensory characteristics of the traditional product.

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Detailed report for Baobab

Baobab Summary

Senegalese consumers in Dakar evaluated four new baobab drinks developed under AFTER project scope: two baobab juices and two syrups. With different sensory characteristics, the new juices were preferred to the syrups. The drinks were, nevertheless, differently appreciated by the identified consumers segments with similar overall liking patterns, which can be related to the intensity of sweetness, acidity, fruit flavour and colour.

Baobab Background

The baobab (Adansonia digitata L.) is important to the livelihood and can be found in most of Sub-Sahara Africa's semi-arid and sub-humid regions as well as in western Madagascar providing food, medicine, etc. (Gebauer et al. 2002 ; Cisse et al. 2009, Caluwé et al., 2010). Baobab fruit pulp is called "Bouy" or Monkey bread is widely used by Senegalese people and it is consumed in different forms (Cisse et al., 2009).
Most of applications of the baobab pulp could include the preparation of refreshing drinks (Diop et al. 2005; Cisse et al., 2009). The pulp of baobab was approved by the European Commission as a convenient additive (Phytotrade Africa 2008). From Senegal also, the fruit is exported towards some European countries

Baobab pulp is a semi processed food. During the preparation, the pulp is ground and sieved to produce a powder, and the powder is finally kept in convenient containers. Baobab fruit pulp is a natural dried fruit pulp. The pulp is used to develop other food by products, such as ice cream, beverages, etc. In the market, the baobab pulp is sold into plastic sachets to avoid water rehydration. It begins to be sold by supermarkets using other specific packaging for many reasons added value. The baobab pulp is used specifically in some way by specific packaging material imposed by the Export market.
The baobab juice is made from baobab fruit or baobab pulp in some cases (in semi industrial level). The local market is well developed for baobab juice. In the cars' station, the streets, the supermarkets, the baobab juice is well commercialized. In the restaurants also, the baobab drink is mostly used as soft drinks for many tourists. The baobab syrup is more commercialized to the drinks in abroad because the shelf life is longer. According the producers (D5.1.1.3), the market of syrup for exportation is developing. In the supermarkets, it is also sold in very nice plastic or glass bottles using sometimes coded design for labelling. The lack of the syrup in street market and market places is due to low demand for the specific related clients.
A previous AFTER study primarily explored the sensory profile and the acceptance of seven different baobab samples (five juices and two syrups) by African consumers (mainly Senegalese). Relationships between the sensory attributes and the characteristics of the products were related to consumer acceptance in order to understand the factors that influenced acceptability of the baobab drinks.
Syrups and juices had different characteristics. Juices were more associated with bouye (or called baobab) attributes (taste and odour) than syrup. Juices were also associated with concentration and beige colour. The commercial syrups were associated to the sweet taste and flavour. They are very close and are the least preferred products by consumers. The correlations highlight that concentration is an important criterion of acceptability for the consumer group as a whole and particularly for the "juice likers".
This study suggests a reengineering approach to stabilize the products in order to increase their shelf life with optimum quality regarding the sensory attributes and consumer acceptance. Optimizing scales for pasteurization shall be conducted in order to have a product without caramel smell.

In view of this, four news Baobab products (BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval) were developed by AFTER researchers using optimized process. The new products were developed at the Laboratoire de Formation Continue en Industries Agroalimentaires of the Ecole Supérieure Polytechnique of Université Cheikh Anta Diop (UCAD), in Dakar. Their manufacturing process was subsequently tested and scaled-up in the pilot plant of Centre Sectoriel de Formation Professionnelle aux Métiers des Industries Agroalimentaires (CSFP IAA), in Dakar and in the ESTEVAL Company.
The sensory quality of the new drinks was evaluated, by Senegalese consumers in Dakar in October of 2014. Sensory properties of the products were evaluated using Just-About-Right intensity scales (JAR) and Check-All-That-Apply (CATA) techniques.

Baobab Methodology

Samples description and preparation
The Baobab drink (BBE) and Syrup baobab Esteval (SBE) were made from fruit of baobab in the ESTEVAL Company. The company has put HACCP in place and all their products are pasteurized. Those products were stored at T° < 4°C until consumption. Baobab drink from powder (BBP), SBC= Syrup baobab cold were processed in the pilot plant of Centre Sectoriel de Formation Professionnelle aux Métiers des Industries Agroalimentaires (CSFP IAA) with applying the good manufacturing practices and good practices hygienic. The processes used are presented in annexe 1. Baobab powder is from Baobab des Saveurs Company (Annexe 2). Table 1 shows the main characteristics of samples.

Table 1 – Main characteristics of samples

Sample	Raw Material	Ratio Baobab/water /time	Pasteurisation
BBE	Baobab fruits	1/6 ; 2 h	85 °C / 30 min
BBP	Powder	1/15 ; 15 min	85 °C / 30 min
SBC	Powder	1/6 ; 15 min	85 °C/15 min
SBE	Baobab fruits	½ ; 2 h	105 °C / 15 min

The syrups samples were diluted 4 to 5 times with potable water prior to tasting to have the same total soluble solids to the baobab drink (130-145 g.L-1).

Figure 1- Baobab drinks

Sensory testing

Participants and consumers sessions
Sensory evaluation was conducted with consumers. This method has been validated by previous studies (Jaeger et al. 2013).

Consumers of Baobab products were non-probabilistically recruited (100). Tasting sessions took place at Ecole Supérieure Polytechnique of Université Cheikh Anta Diop (UCAD), in Dakar and included a written questionnaire in French about other consumption, socio-demographic and attitudinal variables.
All the drinks were transported in cool boxes with ice. Thirty millilitre samples of each of the four baobab drinks tested were served in clear plastic glasses and presented to participants in a sequential monadic mode, following a complete balanced experimental plan. Each sample was identified by a random code with 3 digits. Water was supplied to clean the palate between tastings. Trained enumerators assisted participants in French or in the local Wolof language when required. No information about the samples was provided to participants except for safety and hygiene considerations related to their preparation.
The intensity of five sensory attributes – colour, sweet taste, fruit taste, acid taste -, relatively to participants' ideal level, was measured by ratings provided on a 3-point, just-about-right scale [too weak (TW), just-about-right (JAR), too strong (TS)] (Moskowitz, 1972).

Statistical Analysis
XLSTAT software (Addinsoft SARL, France) and IBM SPPS Statistics, Version 22.0 (IBM Corp., USA). were used to carry out all statistical analyses. The significance of statistical tests was evaluated at $p<0.05$, unless otherwise mentioned.

Pre-Analysis of the sensory/consumer panel
One participant was excluded due to atypical age (z-score >4). One participant provided an atypical overall liking rating for the BBP sample (z-score >4), and two participants provided atypical overall likings for SBE (z-score >3) The responses of these four participants were hence excluded from further analysis, remaining ninety six participants.
The frequency of intensity ratings (TW, JAR, TS) for each of the five sensory attributes evaluated by participants was determined for each sample, and the corresponding proportions calculated. A Correspondence Analysis (CA) was then performed on the contingency table of proportions for all samples and attributes (Popper, 2014). The frequency of intensity ratings for each sample and attribute was finally tallied for each cluster of participants based on overall liking ratings.
A penalty analysis (Popper, 2014) was employed to relate attribute intensity ratings to overall liking ratings for each participant and sample. To this end, participants were grouped according to their intensity ratings for each sample and attribute, and mean overall liking ratings for each group were computed. The overall liking mean drops, or penalties, obtained when comparing the TW and the TS group with JAR participants were then calculated. Weighted penalties (Popper, 2014) were equally computed by taking both the mean drops and the proportion of participants in each group.

Baobab Results and discussion

Evaluation of Intensity of sensory attributes relatively to participants' ideal level, using JAR scales

Figure 4 shows the frequencies of intensity ratings, measured on a 3-point JAR scale, for each baobab drink and sensory attribute evaluated, whereas Figure 5 depicts the first two dimensions of the correspondence analysis performed on these ratings.

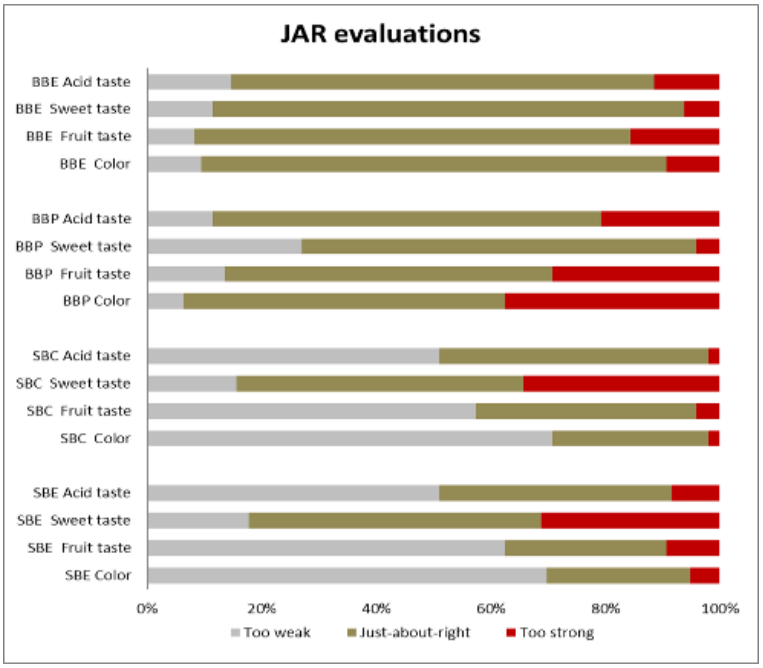

Figure 4 -Frequencies of intensity ratings, measured on a 3-point just-about-right scale, for each sample and sensory attribute evaluated. BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

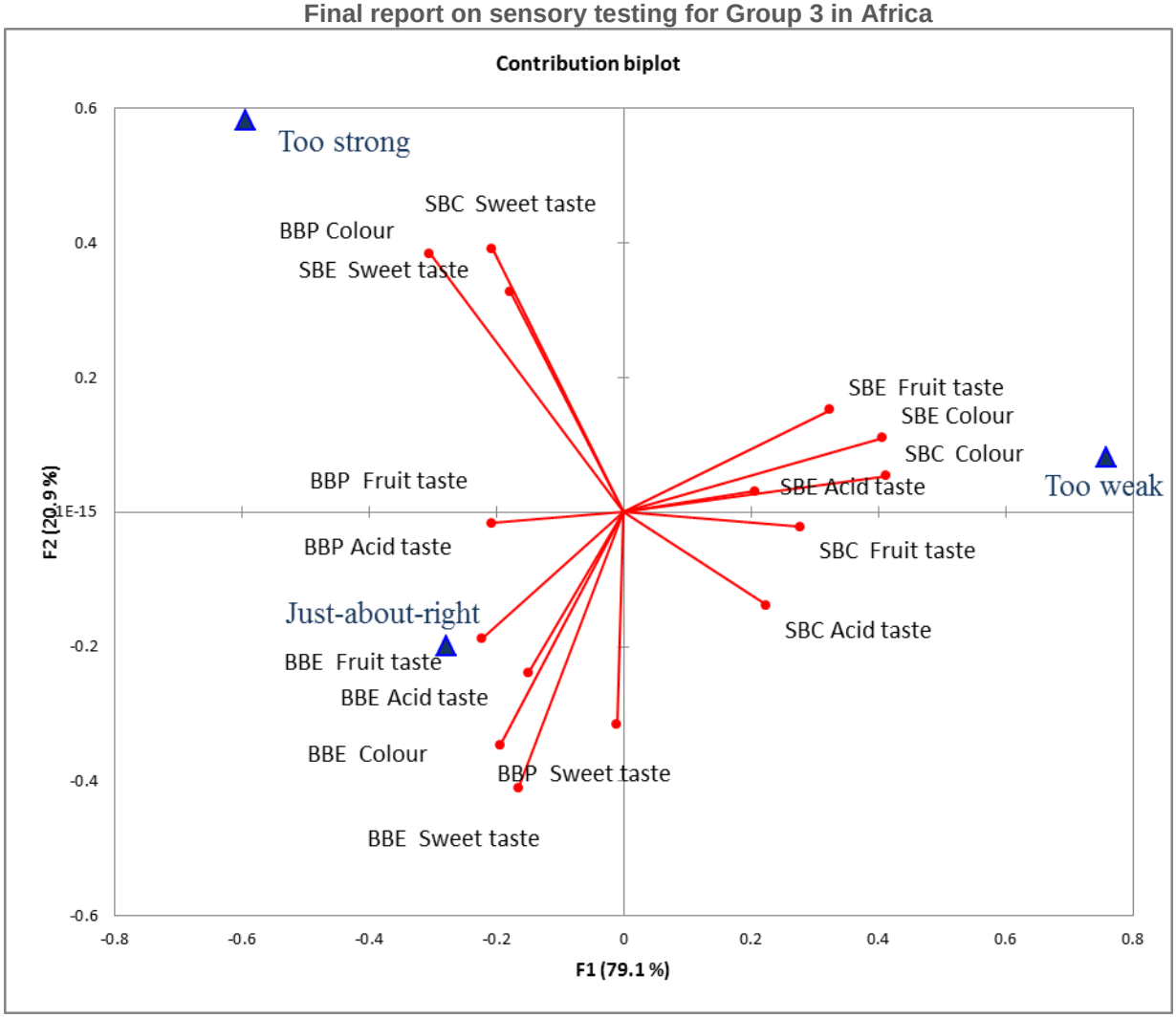

Figure 5 - Representation of the baobab drinks and sensory attributes evaluated in the first two dimensions of a correspondence analysis, performed on attribute intensity ratings measured on a 3-point just-about-right scale (too weak , just-about-right , too strong). BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

A preponderance of JAR ratings was observed for BBE for the four attributes evaluated, with their frequencies ranging from 74 to 82%. This is well in line with overall liking results, which showed that BBE was the preferred drink. For SBE and SBC, TW ratings dominated all attributes' intensity evaluation, with the exception of sweet taste (Figure 6).

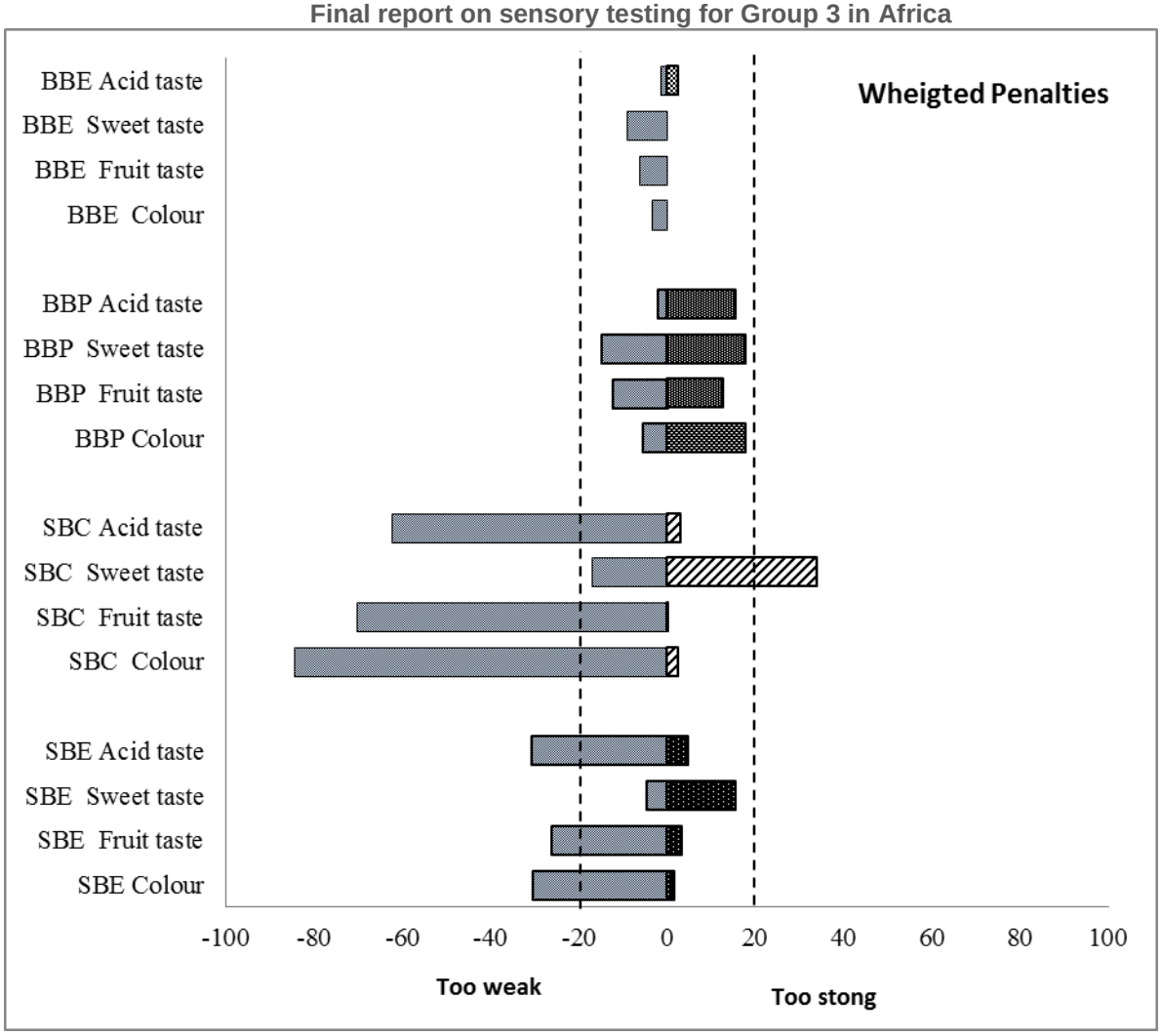

Figure 6 - Representation of the weighted penalty values relating overall liking ratings drops for each sample and attribute in relation with JAR attribute intensity ratings. BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

With the purpose of identifying attributes which appear to have a strong impact on overall liking, weighted penalties were calculated for all samples and attributes. The weighted penalties are represented in figure 9. Mean drops of 1.0 for nine-point overall liking scale and 20% respondents, are often considered the cut-off for a meaningful decline in acceptance related to a particular attribute, for this reason weighted penalties below 20 are usually considered negligible. This was the case for BBE and BBP drinks for all attributes evaluated. For SBC a significant impact of the weak fruit and taste and colour were observed, reflected of the weak bissap taste and odour, colour and acidity, similar but less strong penalties were observed for SBE.

Baobab Conclusion

The reengineered juices had different sensory characteristics to syrups. The attribute that was more distinguished for all samples it was sweetness and all samples were found to be very sweet. Probably, because by the lack of acidity in all of the drinks, this attribute has not been evaluated because the panellists did not consider this attribute to be significant in any of the assessed samples; thus by this fact the sweetness of the drink appears to be more pronounced. The drinks were differently appreciated by the identified consumers segments with similar overall liking patterns, which can be related to the intensity of sweetness, acidity, fruit flavour and colour. Specific descriptors evaluated, since for the least liked drinks, the syrups, the insufficient fruit flavour, colour and acidity significantly penalized the drinks acceptance.

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Detailed report for Jaabi (Group 3)

Jaabi was not tested by a sensory panel in either the EU or Africa. This is because the reengineered Jaabi product had inferior properties to the baseline one and hence would not have a viable market.