Formulation and Sensory Analysis of Cocktails Based on Ginger Oleoresin (*Zingiber officinale* Roscoe), Pineapple Juice (*Ananas comosus* L. MERR) and Bissap Concentrate (*Hibiscus sabdariffa*)

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ABSTRACT

Aims: The aim of this study is to formulate cocktails based on ginger oleoresin, pineapple juice and bissap concentrate in order to contribute to the development of these agricultural products and improve the income of producers.

Study Design: The biological material consists of pineapple juice, ginger oleoresin and bissap concentrate. The oleoresin and the bissap concentrate were supplied respectively by Gazignaire (France) and the Water Chemistry and Natural Substances Laboratory.

Place and Duration of Study: The cocktails were formulated and then subjected to sensory analyzes, from July to October 2018, at the Biochemistry and Food Sciences laboratory at Félix Houphouët-Boigny University.

Methodology: The cocktails were formulated through a composite central plan having as variables the proportions of the pineapple juice, the bissap concentrate and the ethanol composing the cocktail. Thus 15 cocktail formulations were developed, the sensory characteristics of which were estimated.

Results: Hedonic analysis of the formulations indicates acceptance of 12 of them by more than 50% of tasters.In addition, 5 formulations F4; F6; F12; F13 and F15 are preferred in proportions varying between 62% and 77%.The descriptive analysis of these 5 formulations indicates that only the pineapple flavor makes it possible to distinguish them and the F13 formulation is less provided with them.However, these formulations according to their flavor, aroma and texture are classified into 3 groups according to a principal component analysis.Which could offer consumers more choice.

Conclusion: Commercial production of these cocktails could improve the availability of ginger, bissap and pineapple year-round and help improve the income of producers.

1. INTRODUCTION

Plants have always been used by humans for therapeutic or nutritional purposes. Thus knowledge about plants and their traditional uses has only increased [1].Some studies have shown that regular consumption of vegetables and fruit can help to reduce the risk of cardiovascular disease, some cancers and other chronic diseases [2].This major protective role is thought to be due to the vitamins, mineral salts, antioxidant compounds and fibers contained in these agricultural resources [3]. These plants contain biomolecules active in the prevention and treatment of gastric and colorectal, prostate and ovarian cancers [4].In Côte d'Ivoire, some of these plants are produced in particular ginger (*Zingiber officinale*), guinea sorrel or bissap (*Hibiscus sabdariffa*) and pineapple (*Ananas comosus* L. MERR).

Indeed, ginger is grown mainly in the departments of Bongouanou (Moronou region), Divo (Lôh-Djiboua region), Gagnoa (Gôh region), Soubré (Nawa region), Tiassalé (Agneby-Tiassa region) and Koun-Fao (Gontougo region) and sold mainly fresh for the manufacture of juice [5]. It is used as a spice to enhance the taste of

foods and has many medicinal properties [6]. These functional properties of ginger have been attributed to the antioxidant power of the constituents of its essential oil and its oleoresin [7,8]. In the food industry, the antioxidant property of ginger is used to inhibit microbial and fungal growth in order to preserve food [9,10]. Regarding bissap, it is produced in the northern regions of Côte d'Ivoire and used in food for the production of jam, jelly and especially a refreshing drink called "bissap". These products are attractive red in color with a more or less tangy taste depending on the varieties of chalices used. This red color is due to the richness of the chalices in anthocyanins (antioxidants) which would present several nutritional, medicinal or pharmaco-cosmetic interests [11]. As for pineapple, it is produced in the regions of South Comoé (Bassam, Bonoua, Aboisso) and widely consumed as fresh fruit, but also in juice or integrated into exotic foods.One of the characteristics of the stem and the fruit of pineapple is its richness in cysteine proteases, in particular bromelain and cysteine endopeptidases [12]. These enzymes perform multiple biological functions in virtually all aspects of physiology and tissue development [13]. Indeed, bromelain has multiple properties

including anti-inflammatory, analgesic, healing, fluidifying, immunostimulant and especially anticancer [14].

In Côte d'Ivoire, drinks produced from each of these plants (ginger, bissap, pineapple) are popular with consumers [8]. However, they show severe degradation during their conservation and are sometimes indigestible [15,16]. Also the combination of these three drinks in the form of cocktails, could provide drinks richer in nutrients and more digests. In addition these cocktails could be more stable during their conservation with the use of oleoresin instead of ginger rhizome.The aim of this study is to formulate cocktails based on ginger oleoresin, pineapple juice and bissap concentrate to contribute to the valuation of these agricultural commodities and improve producers' revenues.

2. MATERIALS AND METHODS

2.1 Biological Materials

The biological material consists of pineapple juice (*Ananas comosus*), ginger oleoresin, bissap concentrate (*Hibiscus sabdariffa var sabdariffa*) and mint extract (*Mentha spicata*).The oleoresin and bissap concentrate were supplied respectively by Gazignaire (France) and the Water Chemistry and Natural Substances Laboratory of the Institut National Polytechnique Felix Houphouët-Boigny (Côte d'Ivoire).

2.2 Methods

2.2.1 Pineapple juice production

The pineapples were washed and soaked in chlorinated water (0.01°chlorometric) for 20 min, then rinsed and peeled to remove the epicarp dandruff. Then, the pulp obtained was cut into strips and crushed using a metal grinder (Moulinex). The ground material was filtered through a sieve having 0.5 mm mesh diameter and the resulting filtrate was also filtered through a finer mesh sieve (75 µm in diameter) [8]. The final filtrate was packaged in volumes of 1 liter and then stored in the refrigerator (4°C) before use (Fig. 1).

2.2.2 Cocktails formulation of ginger oleoresin, pineapple juice and bissap

Experimentation of cocktails formulation based on ginger oleoresin, pineapple juice and bissap was carried out using a composite central plane (CCP).The experimental domain of the study consists of 3 factors which take into account the bissap/water ratio (X1), the pineapple juice/water ratio (X2) and the ethanol/water ratio (X3) (Table 1).The composite central plane thus presents a list of 8 factorial tests, 6 star tests and 1 test at the center of the experimental domain thus 15 formulations noted from F1 to F15 to be produced (Table 2).The axial values (Table 1) were determined using equation 1 and the products obtained from the different formulations were subjected to sensory analysis [8].

$$X_k = X_{cent} + Z_k \times \frac{X_{max} - X_{min}}{Z_{max} - Z_{min}} \qquad (1)$$

With:

Xk= factor coded value ;
Xcent= actual value of the same factor at the center ;
Zk= coded value of the limit of variation.

2.2.3 Production of ginger oleoresin cocktails, pineapple juice and bissap

The cocktail production diagram is shown in Fig. 2.For each cocktail, in a 500 mL Erlenmeyer flask containing 1 g of oleoresin, a volume varying from 100 mL to 150 mL of ethanol (96%) was added.The mixture was homogenized until the oleoresin was completely dissolved. Then, 100 mL to 200 mL of bissap concentrate, 100 mL to 200 mL of the pineapple juice filtrate, 20 mL of lemon juice, 20 mL of mint extract and 100 g of sugar were added to the mixture, followed by adding a sufficient amount of distilled water to dissolve the sugar completely. The mixture was transferred to a 1 liter test tube and the volume brought to the mark with distilled water. The cocktail thus formed was filtered through a sieve with mesh size of 75 µm in diameter then packaged in volumes of 1 liter and kept in the refrigerator for subsequent analyzes [8].

2.2.4 Sensory analysis of cocktails

The cocktails formulated from the composite central plan were subjected to sensory analyzes from tasting tests carried out, from July to October 2019, at the Biochemistry and Food Sciences laboratory at Félix Houphouët-Boigny University. Descriptive tests and hedonic appreciation tests were performed.
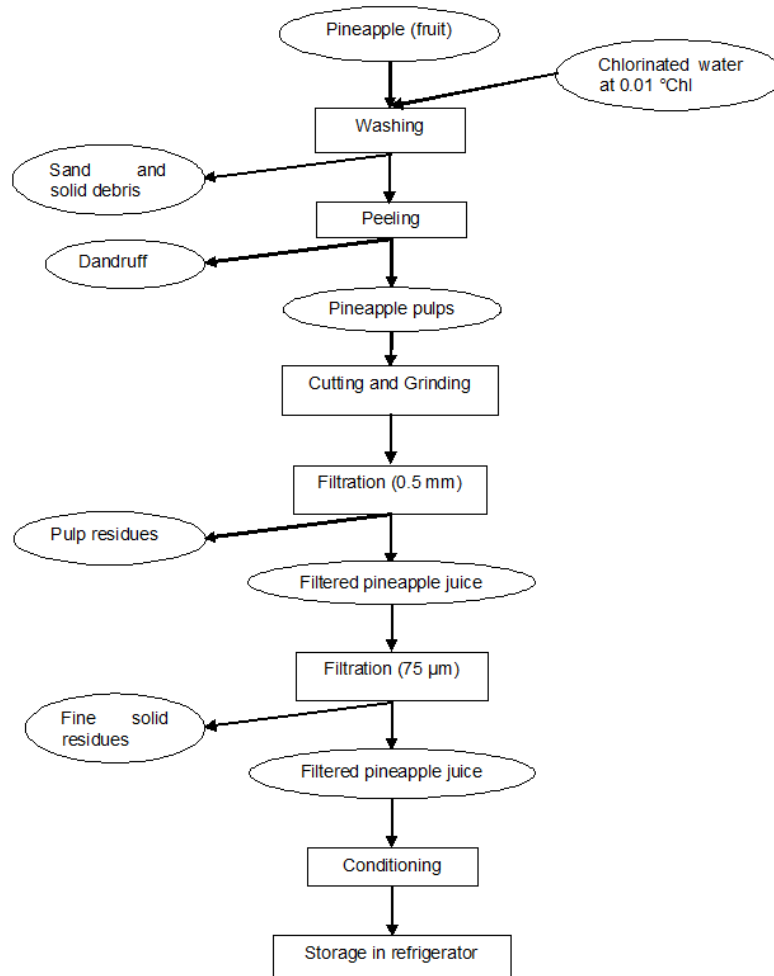
Fig. 1. Diagram of pineapple juice production

Table 1. Experimental parameters of the composite central plane

Technological parameters (X)	Coded levels/Actual values				
	-1,682	**-1**	**0**	**1**	**1,682**
Bissap/water ratio (v / v): X_1	10/100	12.03/100	15/100	17.97/100	20/100
Pineapple/water ratio (v/v): X_2	10/100	12.03/100	15/100	17.97/100	20/100
Alcohol/water ratio (m/v): X_3	10/100	11.01/100	12.5/100	13.99/100	15/100

2.2.4.1 Hedonic analysis

The hedonic analysis was performed with a group of 90 untrained people (men and women).Each formulated juice has been subjectively rated for the pleasantness of its characteristic aroma, flavor, fluidity and color. The overall acceptance of each sample was also estimated.

For this analysis, 30 mL of each cocktail made from oleoresin ginger, pineapple juice and bissap concentrate were served to the tasters in coded glasses and in random order. After the sample was put in the mouth, the panellist's taste satisfaction was expressed on a scoring sheet provided for this purpose and comprising a scale of 9 amplitude points; level 1 expressing total dissatisfaction with the sample parameter, while level 9 represents the extreme pleasure that is felt from it [8,17].

Table 2. Experimental plan of the composite central plane

Test group	N° Tests	Actual values of parameter levels		
		X1 (v/v)	X2 (v/v)	X3 (m/v)
Factorial tests	1	12.03/100	12.03/100	11.01/100
	2	17.97/100	12.03/100	11.01/100
	3	12.03/100	17.97/100	11.01/100
	4	17.97/100	17.97/100	11.01/100
	5	12.03/100	12.03/100	13.99/100
	6	17.97/100	12.03/100	13.99/100
	7	12.03/100	17.97/100	13.99/100
	8	17.97/100	17.97/100	13.99/100
Star trials	9	10/100	15/100	12.5/100
	10	20/100	15/100	12.5/100
	11	15/100	10/100	12.5/100
	12	15/100	20/100	12.5/100
	13	15/100	15/100	10/100
	14	15/100	15/100	15/100
Tests at center	15	15/100	15/100	12.5/100
	Level -1	**10/100**	**10/100**	**10/100**
	Level +1	**15/100**	**15/100**	**12.5/100**
	Level 0	**20/100**	**20/100**	**15/100**

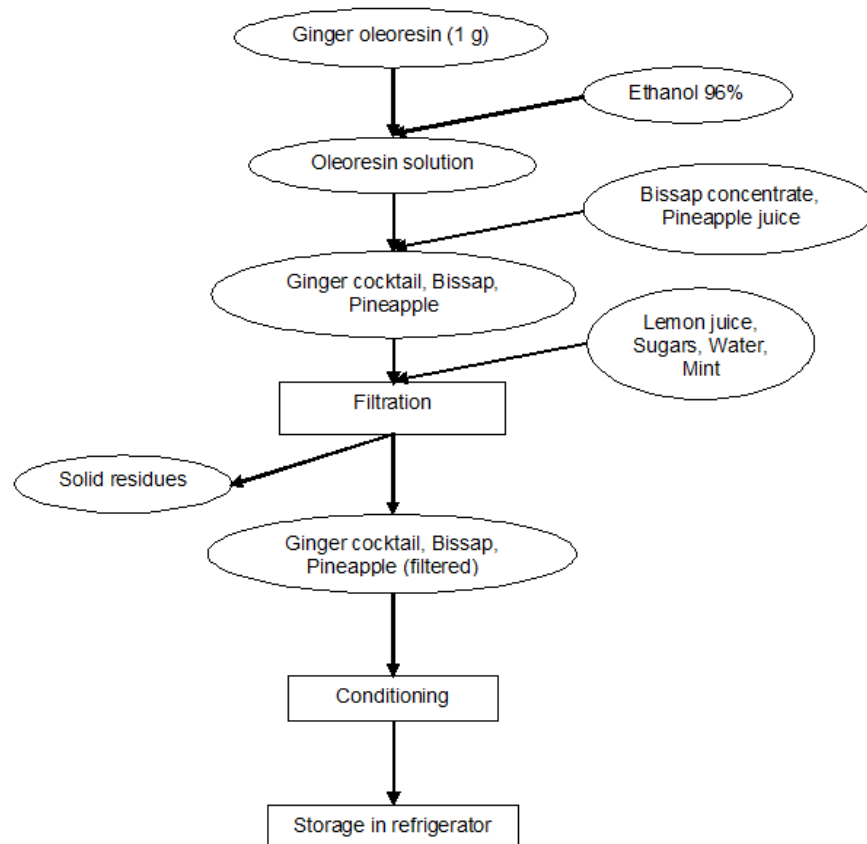*X1 = Bissap/water ratio (v/v), X2 = Pineapple juice/water ratio (v/v), X3 = Ethanol/water ratio (v/v)*

Fig. 2. Production diagram of ginger oleoresin cocktails, bissap and pineapple

2.2.4.2 Descriptive analysis

The descriptive sensory analysis of the cocktails aimed to objectively specify the intensity of the perception of some organoleptic characteristics, in particular the color of the product (red), the characteristic aroma of ginger, bissap, pineapple and mint, the flavor (pungent, sweet, sour) and turbidity (clear or cloudy) of the cocktail. This analysis required the use of panelists (human subjects) previously trained in the recognition and identification of the levels of perception of the targeted descriptors.

Selection and Training of Panelists: twenty-five (25) people (men and women), were recruited on the basis of their availability and their ability to distinguish aromas, colors, flavors, fluidity and appearance of liquid foods. These people were trained in the methodology for analyzing and assessing the qualitative characteristics of cocktails made with oleoresin ginger, pineapple juice and bissap, then instructed in the taste areas of the tongue. At the end of these selection tests, a panel of 15 qualified tasters was formed and familiarized with the cocktail found on the market, during eight tasting training sessions, before carrying out the sensory description of the cocktails formulated.

Descriptive Analysis of of the Cocktails Formulated: The actual descriptive analysis of the formulated cocktails was done by serving each panelist 30 mL of each cocktail sample in disposable rubber glasses of the same appearance and bearing different alphanumeric codes. The different samples were presented monadically to each panelist in a randomized order. After placing each sample in the mouth, the panelist then indicated the value of the intensity perceived for each parameter evaluated (red color, ginger flavor, bissap flavor, pineapple flavor, mint flavor, sweet flavor, acid flavor, spicy flavor and cloudy appearance).A rating scale of these intensities, of 7 amplitude points, was designed for this purpose: the mark 0 indicating the total absence of perception of the sensory parameter whereas at level 7, the parameter is extremely perceived [8,17].

2.2.5 Statistical Analyzes

The homogeneity of the means, for descriptive sensory analysis, was assessed by one-way analysis of variance (cocktail formula), using the Statistical Program for Social Sciences (SPSS 22.0, USA) software. As for hedonic analysis, khi-square test (X2) for comparison of proportions has been performed. In addition, multivariate principal component analysis (PCA) was performed using the STATISTICA version 7.1 software to structure the variability between the cocktails and their sensory descriptors [8,18].

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Sensory acceptance of formulated cocktails

All the cocktails formulated were accepted by at least 50% of the tasters with the exception of the formulations F3 (45.16%), F7 (48.57%) and F10 (40%). The results of the acceptance of cocktails accepted by more than 62% of the tasters are presented in Table 3.For these oleoresin cocktails of ginger, pineapple juice and bissap concentrate, the proportion of tasters who accepted them varied between 62.86% and 77.15%. Furthermore, 0% to 8.57% of tasters neither accept nor reject said cocktails. On the other hand, 19.99% to 37.17% of tasters did not like them. These are the formulations F4 (66.67%), F6 (62.86%), F12 (71.43%), F13 (77.15%) and F15 (62.86%).It is these formulations which have undergone descriptive tests.

3.1.2 Descriptive sensory profile of cocktails

3.1.2.1 Color, texture, flavor and aroma of cocktails

The red coloring varies from 3.93 / 7 (F12) to 4.57 / 7 (F4) in formulated cocktails. However, the descriptive test results show that there is no significant difference for the color red (p = 0.224).Regarding the texture of the cocktails, represented by turbidity, the tasters felt that there was no significant difference between the formulations (p = 0.840) (Fig. 3).

The results, on the sweet, sour and pungent flavors of cocktails, indicate that the sweet flavor of cocktails is statistically invariable regardless of the formulation (p = 0.882).Regarding the acidic flavor, the values are between 2.86 / 7 and 3.64 / 7 and do not differ significantly whatever the formulation (p = 0.182).As for the pungent flavor, it does not present a significant difference (p = 0.745) whatever the formulation (Fig. 3).

Table 3. Percentage of panelists translating their preference for accepting cocktails to more than 62%

| Levels of appreciation		1	2	3	4	5	6	7	8	9	Acceptance (%)	X^2	p
General trend			Dissatisfaction			NANR		Satisfaction					
Distribution Théorique (%)		11,11	11,11	11,11	11,11	11,11	11,11	11,11	11,11	11,11			
Formulations	F4	3,33	6,67	10	6,67	6,67	26,67	23,33	16,66	0	66.66	59,99	0,00
	F6	0	5,71	14,29	17,14	0	34,29	17,14	2,86	8,57	62.88	87,37	0,00
	F12	0	0	8,57	14,29	5,71	25,71	28,57	14,29	2,86	71.43	79,99	0,00
	F13	0	5,71	5,71	8,57	2,86	31,43	28,57	14,29	2,86	77.15	94,7	0,00
	F15	0	2,86	17,14	8,56	8,57	34,29	22,86	2,86	2,86	62.87	94,71	0,00

NANR: neither accepted nor rejected; F: formulation; X2: Chi-square statistical test value; P: observed probability value. The values of P <0.05 reflect a significant difference between the percentages of panelists corresponding to the levels of appreciation of each sensory parameter

The ginger, bissap and mint aromas are statistically invariable in the cocktails formulated. Concerning the pineapple flavor, a significant difference is observed between the values (p = 0.01) and the F4 formulation has the strongest intensity (3.50 / 7) while the F13 formulation has the weakest (2.50 / 7) (Fig. 3).

3.1.2.2 Description of the sensory variability of the cocktails formulated

At the end of the principal component analysis (PCA), 4 components with eigenvalues between 0.45 and 5.05 make it possible to describe the sensory variability of the cocktails formulated (Table 4). Among these 4 factors, the first two components (1 and 2) have respective

eigenvalues of 5.05 and 2.03 and express 78.67% of the total variability. They made it possible to make the representation in the plane of the correlation between the cocktails formulated (Fig. 4B) and the sensory descriptors (Fig. 4A).This projection indicates that the pungent and sour flavors, mint and ginger aromas are positively correlated to component 1 as is the F15 formulation. Thus, the F15 formulation is distinguished by significant values relating to ginger and mint aromas, with acid and pungent flavors. Regarding the F6 and F13 formulations, they are characterized by the most intense sensory values relating to sweet flavour, red color and cloudy appearance. While the F4 formulation has the highest values relating to bissap and pineapple aromas.
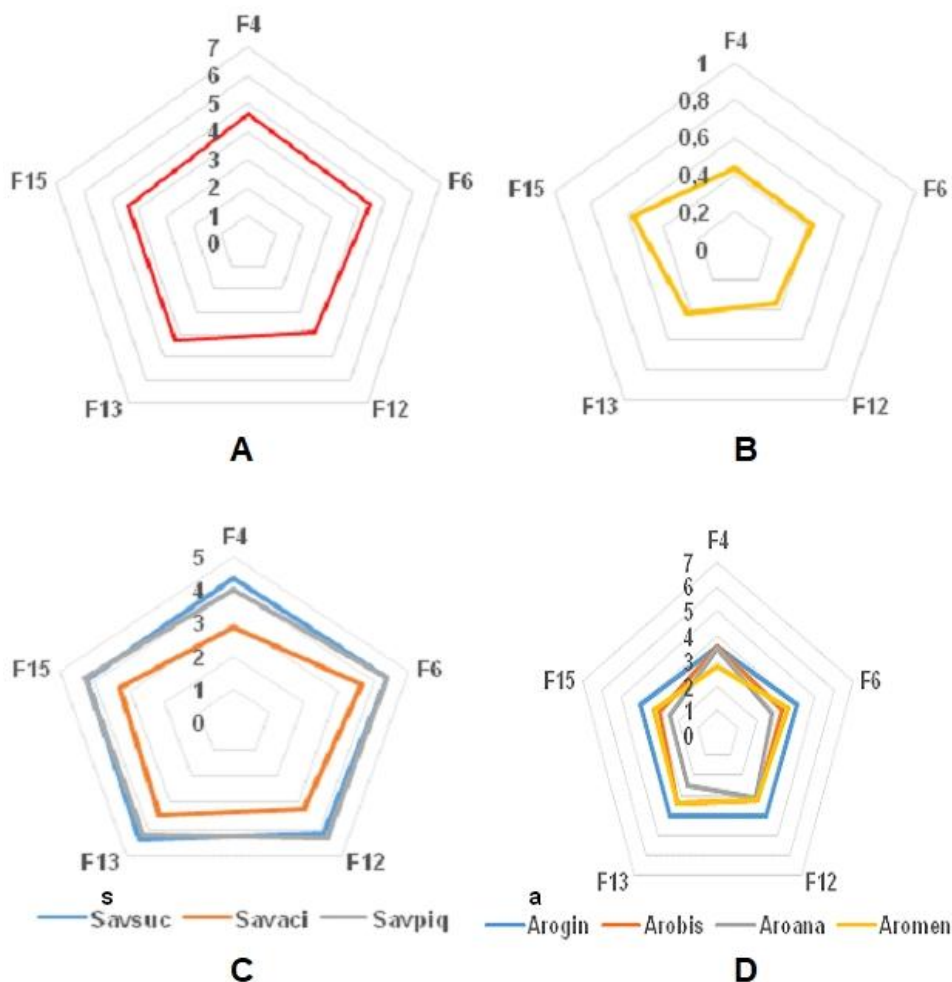
Fig. 3. Intensity of red color (A), cloudy appearance (B), flavors (C) and aromas (D) of formulations accepted at more than 62%
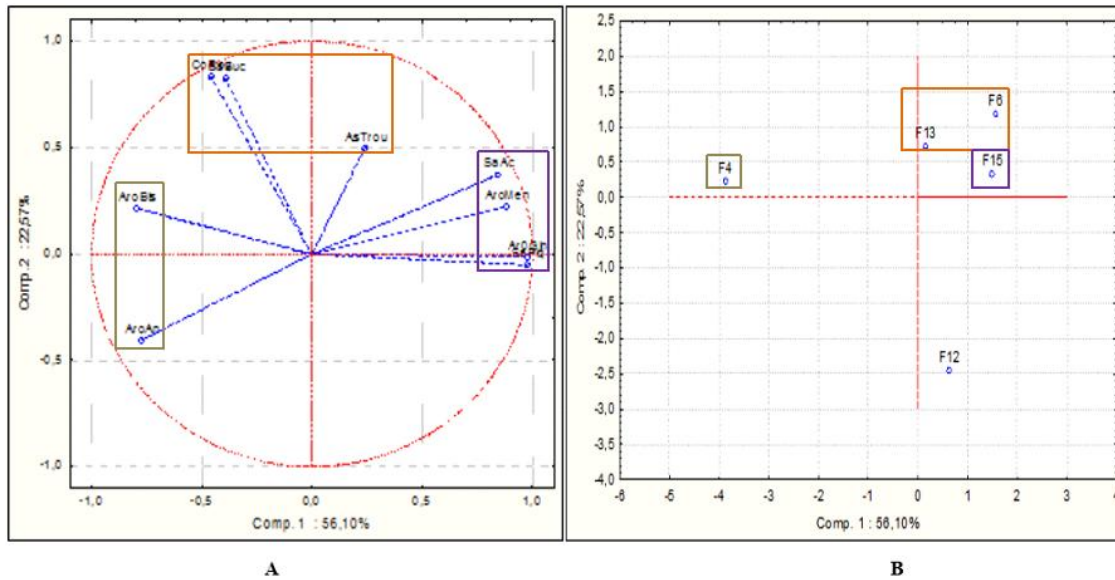[s]*Savsuc: sweet flavor, Savaci: sour flavor and Savpiq : pungent flavor*
[a]*Arogin: ginger aroma, Arobis: bissap aroma, Aroana: pineapple aroma and Aromen: mint aroma*

43

Table 4. Matrix of eigenvalues and percentage of variability expressed by the 4 factors of the principal component analysis

Composantes	1	2	3	4
Valeur propre	5,05	2,30	1,49	0,45
Variabilité exprimée (%)	56,10	22,57	16,36	4,97
Cumul valeur propre	5,05	7,08	8,55	9,00
Cumul variabilité exprimée (%)	56,10	78,67	95,03	100,00

Fig. 4. Distribution of sensory descriptors (A) and cocktails accepted at more than 62% (B) in the factorial plane Comp.1- Comp.2 of the principal component analysis (PCA)
Arogin: ginger aroma, Arobis: bissap aroma, Aroana: pineapple aroma, Aromen: mint aroma, Asptrou: turbidity, CoRou: red, Savsuc: sweet flavor, Savaci: sour flavor and Savpiq: pungent flavor

3.2 Discussion

Cocktails formulated with ginger oleoresin, bissap concentrate and pineapple juice have received at least 50% consumer acceptance. Indeed, 12 of the 15 formulations (80%) are concerned by this acceptance. This is remarkable for a new food product that is, in principle, unknown to consumers. In addition, 5 of the 15 formulations (33%) received acceptance from more than 62% of consumers. These results are better than those obtained by Sidibé et al. [8] in their formulation study of ginger nectar based on ginger oleoresin. Among the nectars formulated by these authors, five (5) were accepted by the tasters at rates between 57.14% and 77.15% of which three (3) benefited from rates between 60% and 77.15%.These differences observed in the number of formulations accepted by at least 50% of the tasters (12 vs. 5) or at least 60% of the tasters (5 vs. 3), could be explained by their composition in

sugar, bissap, pineapple or alcohol. This trend of increasing appreciation rate could be improved by a more sustainable presence on the market of these cocktails with an improvement of their sensory qualities.

The descriptive sensory analysis of formulations F4, F6, F12, F13 and F15 shows that the intensities of the red coloration of the formulations do not differ significantly despite the variation in the proportions of bissap concentrate. This would mean that the chosen proportion interval (10% to 20%) for the bissap concentrate does not allow to discriminate the cocktails through the red coloring. However, all the accepted formulations, more than 62%, have proportions of bissap concentrate at least equal to 15%.This would mean that the bissap concentrate does not allow to discriminate the formulations by the red coloring but its proportion would play a role in the acceptance of the said formulations.

Contrary to what was observed with the drink "gnamakoudji" (ginger juice), found on local markets, the formulations made in the present study are weakly turbid (0.36/7 to 0.57/7) which could presage weak deposits during their storage. This could be explained by the low starch content of the formulated cocktails. Because two (2) of these components are plant extracts (ginger oleoresin and bissap concentrate).Some authors have reported that rhizomes contain protein residues and lipids in varying proportions, but mostly starch, observable by a whitish deposit after juice production [15] and whose intensity increases with storage time.

Among the sensory parameters analyzed, the sweet, sour, pungent, ginger, bissap and mint flavors do not allow to discriminate the formulations. In fact, no significant difference was observed in the flavor and aroma of these formulations. This could be explained by the constant proportions of oleoresin (0.1%), mint extract (2%), lemon juice (2%) and sugar (10%) in the formulations. These results are contrary to those of Sidibé et al. [8] who observed variability in pungent, sweet, and sour flavors in their ginger oleoresin nectar formulations. This difference could be explained by the fact that these authors had varied the proportions of oleoresin from 0.025% to 0.1%, lemon juice from 1% to 5% and sugar from 1% to 10% in the formulations.

Cocktails formulated from ginger oleoresin, bissap concentrate and pineapple juice could be classified as functional foods due to their constituent elements. Indeed, bissap and pineapple would contribute proteins, lipids, fibers, carbohydrates, organic acids, minerals and phenolic compounds to the formulations [19]. While ginger oleoresin, through its pungent flavor, would provide polyphenolic compounds including gingerol and its derivatives [7]. Thus these formulations would provide consumers with compounds against flatulence, sore throat, constipation, motion sickness, nausea, vomiting and premature aging [20]. In addition, formulated cocktails could be stored longer (two months) because of the antioxidants they would contain [21].

These formulated cocktails offer three (3) choices to consumers. Those consumers who are attracted by the bissap and pineapple flavors can turn to the F4 formulation. While those who are attracted by the red color, the sweet taste and the turbidity can go for the F6 and F13

formulations. Finally, those who like the ginger and mint aromas, the acid and pungent flavors can turn to the F15 formulation.

4. CONCLUSION

This study formulated cocktails based on ginger oleoresin, bissap concentrate and pineapple juice through a composite central plane. Among these formulations, five (5) (F4, F6, F12, F13 and F15) were accepted by more than 62% of tasters. These formulations, according to their flavors, aromas and textures, were classified into three (3) groups according to a principal component analysis. This could provide consumers with more choices. Commercial production of these cocktails could improve the availability of ginger, bissap and pineapple year-round. It could also help improve the income of food producers.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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