Original Research Article

ORGANOLEPTIC APPROACH OF DRINKS FORMULATIONS FROM COFFEE AND COCOA EXTRACTS

ABSTRACT

Aims: The current work evaluates some organoleptic characteristics of various formulations from diluted coffee and cocoa extracts.
Study design: Raw extract produced from Cocoa and Coffee beans, Diluted Extract Formulations processed, and Organoleptic Analyses performed for Sensory profile and Sensory acceptance of the formulations.
Place and Duration of Study: Laboratory of Biochemistry and Food Sciences from Felix Houphouët-Boigny University in Abidjan, between March 2019 and July 2019.
Methodology: Six (6) diluted formulations of coffee extracts (dilutions 1/5, 1/10, and 1/20) and cocoa extracts (dilutions 1/3, 1/5, and 1/8) were prepared using variable amounts of concentrated raw coffee and cocoa extracts and mineral water. The acceptance of these formulations by consumers was thus probed, just as the sensory perception index of their appearance (brown), texture (turbidity), and flavor (sweet, acid, bitter). The sensory assessment was achieved from taster's panels.
Results: The coffee extract dilutions 1/5 to 1/20 were filled invarious coffee aroma (2.58/7 to 3.25/7) and sweetness (0.92/7 to 1.33/7). But the coffee dilution 1/20 has enjoyed 50% tasters and highlighted light brown appearance (2.58/7) and light acid flavor and bitterness (1.92/7 and 2.25/7). The cocoa extract dilutions 1/3, 1/5 and 1/8 exhibited similar and light sweetness of 1/7 to 1.33/7. However, the dilution 1/8 was accepted by 48.33% panellists. It was rated with lightest brown appearance (3.25/7), cocoa aroma (2.67/7), and bitterness (3.08/7), and also moderate acid flavor (2.67/7).
Conclusion: Diluted extract formulations of coffee 3 (dilution 1/20) and cocoa 3 (dilution 1/8) could be used for the formulation of new drinks products.

Keywords: coffee, cocoa, sensory analysis, diluted extract formulations

1. INTRODUCTION

Côte d'Ivoire is the world's leading producer of cocoa since 1978, and the third African exporter of Robusta coffee **[1, 2]**. During the 2016-2017 season, cocoa production reached 1,848,233 tons, either close to 42% of world supply **[1]** while that of coffee is currently estimated at 76,539 tons **[2]**. Cocoa and coffee are strategic agricultural products for Côte d'Ivoire. Indeed, they play a key role in the country's economic prosperity. At the social level, cocoa and coffee provide numerous livelihoods in primary, secondary, and tertiary fields of activity, since plantations are managed by over 1,500,000 rural populations and number of stakeholders are involved in the products' trading **[3]**. Hence, the main income of around five million people are estimated to derive from the cocoa and coffee production. Economically, cocoa alone provides around 40% of export earnings and contributes for more than 15% to

the Gross Domestic Product (GDP) **[4]**. Cocoa and coffee are exported for consumption using different selected criteria such as the taste qualities **[5]**.

Cocoa is a very important ingredient in pharmaceuticals as well as in various kinds of food, namely cake, cookies, chocolate confectionery, chocolate spread, cocoa drinks, food for children, ice cream and sweets **[6]**. As for coffee, it has long been known as a good stimulant for the body and brain activity thanks to the caffeine it contains. Many research works have shown that it improves concentration, mental and physical performance, reduces the tiredness feeling, and supports the regulation of body weight thanks to its satiety effect **[7]**.

Despite the prosperous involvements dealing with the cocoa and coffee sectors, only 6% of reaped currency reaches the producing countries and 2% to the farmers **[8]**. This situation is of significant obstacles hindering the development of this agricultural sector and is partly due to the lack of the raw products processing in farming countries. Thus, farmers' incomes become hermetically dependent on fluctuations in world prices, characterized by the high volatility linked to the moods of international consumers **[9]**. Domestic processing of raw materials in producing countries therefore appears as right option for challenging this situation and strengthening the local consumption. By the way, researches implementation for new products deriving from the raw materials could successfully improve their local consumption.

Concentrates products are known to be resulting from two membranes processes for clarifying and concentrating plant fluids. These are Tangential Microfiltration (TMF) generally used for clarifying biological fluids derived from animal or vegetable raw materials **[10]** and Reverse Osmosis (ROS) used to remove the solvent through a dense membrane in order to concentrate the low molecular weights compounds while recovering the pure demineralized solution **[11]**. Such processes applied to coco and coffee result in concentrated products with high contents of bioactive compounds, namely polyphenols and alkaloids (i.e. caffeine and theobromine), which are of current healthy food products highly targeted by the food factories and strongly consumed throughout the world.

This study focusses the development of concentrated liquid extracts formulations of cocoa and coffee in order to promote the local consumption and improve the main incomes from these raw products. Specifically, the attempt consists in the production of diluted formulations from concentrated cocoa and coffee extracts, the implementation of descriptive sensory analysis of the formulations for recording the main sensory profiles, and the assessment of hedonic traits for the general acceptance of formulations.

2. MATERIAL AND METHODS

2.1 Plant Material

The biological material was constituted of concentrated cocoa extracts (Theobroma cacao L.) and coffee (Coffea canephora) provided by the Laboratory of Water Chemistry and Natural substances from Félix Houphouët-Boigny National Institute, Yamoussoukro, Côte d'Ivoire.

2.2 Sampling for production of the cocoa and coffee extracts dilutions

Concentrated cocoa extract was diluted with water and three (3) dilutions were achieved, namely dilutions 1/3, 1/5, and 1/8. Regarding coffee formulations, the raw concentrated

coffee extract was diluted with water and three (3) dilutions were achieved, namely dilutions 1/5, 1/10, and 1/20. Dilutions were formulated as shown in tables I and II.
Table I: Formulation of diluted cocoa extracts

Intrants	Dilution 1 (1/3)	Dilution 2 (1/5)	Dilution 3 (1/8)
Concentrated extract volume (mL)	1000	600	375
Mineral water volume (mL)	2000	2400	2625
Final volume (mL)	3000	3000	3000

The diluted extracts were conditioned by volumes of 1 litre then conserved to the refrigerator before their analysis.

Table II: Formulation of diluted coffee extracts

Intrants	Dilution 1 (1/5)	Dilution 2 (1/10)	Dilution 3 (1/20)
Concentrated extract volume (mL)	600	300	150
Mineral water volume (mL)	2400	2700	2850
Final volume (mL)	3000	3000	3000

The diluted extracts were conditioned by volumes of 1 litre then conserved to the refrigerator before their analysis.

2.3 Sensory analysis of diluted cocoa and coffee extracts

The sensory analysis consisted in quantitative assessing the main sensory traits of the diluted cocoa and coffee extracts formulations. So, descriptive tests and hedonic appreciation were achieved by panellist tasters. The tasting sessions were achieved at the Laboratory of Biochemistry and Food Sciences from Felix Houphouët-Boigny University, Abidjan, Côte d'Ivoire. Each taster has used 50 mL per formulation sample provided in disposable rubber plates. The sensory responses have been given by scores using appropriate rating-scales.

2.3.1 Descriptive sensory analysis

Fifteen (15) available voluntary panellist tasters between 20 and 40 years of age were selected after tests of recognizing and to appreciating the perception depth of appearance, aroma, flavor, and turbidity from food substances. Panellists have been trained for the methodology of analysis and appreciation qualitative characteristics selected according to the requirements of sensory analysis, trained on the taste areas of the tongue and accustomed to coffee and cocoa extracts found in the trade. For the evaluation of formulations extracts, panellists were invited to check the sensory traits of samples previously anonymized with random codes and filled in random orders of presentation, then to indicate the right value of the intensity felt by fitting a 7 paces rating scale provided. The rating scores ranged from 0 when the sensory parameter isn't perceived at all to 7 when it's extremely felt.

2.3.2 Hedonic acceptance analysis

The hedonic analysis was achieved by a group of 60 people (men and women) untrained and aged between 20 and 40 years. Panellists were invited tell their acceptance size about the appearance, aroma, flavor, and turbidity of cocoa and coffee formulations. These acceptance tests were achieved using a 9 points rating scale from which the level 1 translated extreme disagreeability while 9 related to extreme pleasure felt **[12]**.

2.4 Statistical analysis

Data were recorded from Microsoft Excel software for statistical analysis at 5% significance. For the descriptive sensory analysis, the statistical treatment consisted in a one-way analysis of variance (the extract formulation) followed by SNK means comparison, using the Statistical Program for Social Sciences software (SPSS 22.0, USA). Hedonic scores were checked from a Chi square (X^2) statistical non-parametric test for proportions comparison **[13]**. Furthermore, multivariate analysis consisting in principal component analysis (PCA) was performed using STATISTICA software (STATISTICA version 7.1) for structuring the variability between formulations and sensory descriptors.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Sensory profile of cocoa diluted formulations

From six (6) sensory descriptors assessed by panellists, the sweet flavor is the most weakly felt by panellists and without any significant difference (P= 0.42) between the cocoa formulations (1/7 to 1.33/7). The brown appearance, the particular cocoa aroma, the acid taste, and the bitterness are more rated (P<0.05) from the cocoa extract formulation at dilution 1/3 with respective scores of 5.75/7, 4.08/7, 3.42/7, and 4.33/7, against lower perception scores from dilution 1/8. Oppositely, the most diluted cocoa extract formulation displays greater cloudy texture (3.33/7) compared to the dilution 1/3 (2/7) as shown in figure 1. The extract formulation dilution 1/5 is rated with intermediate score for the brown appearance (4.58/7), the turbidity (2.67/7), and the bitterness (3/75/7), whereas it's closer the most diluted formulation regarding the cocoa aroma (3.08/7) and acid taste (2.33/7).

3.1.2 Sensory profile of coffee diluted formulations

Four sensory descriptors, namely brown appearance, turbidity, acid taste, and bitterness significantly differentiate (P<0.05) the coffee diluted extract formulations prepared. The formulations have been rated low turbidity scores below 3/7. However, the coffee extract dilution 1/20 records the most cloudy texture score (2.83/7) relatively to dilution 1/10 (2.25/7) and dilution 1/5 (1.83/7). Besides, the coffee dilution 1/8 provides the weakest scores regarding the brown appearance (2.58/7), the acid taste (1.92/7), and the bitterness (2.25/7), while these traits are more felt from dilution 1/5 (5.5/7, 3.75/7, and 4.17/7, respectively) and even from dilution 1/10 (3.92/7, 3.08/7, and 3.58/7, respectively). Besides, the particular coffee aroma and the sweet flavor do not show any significant variation (P>0.05) from the diluted coffee extract formulations, with scores oscillating between 2.58/7 and 3.25/7 for the coffee aroma and 0.92/7 and 1.33/7 for the sweetness as the weakest sensory trait felt from the coffee formulations prepared (figure 2).

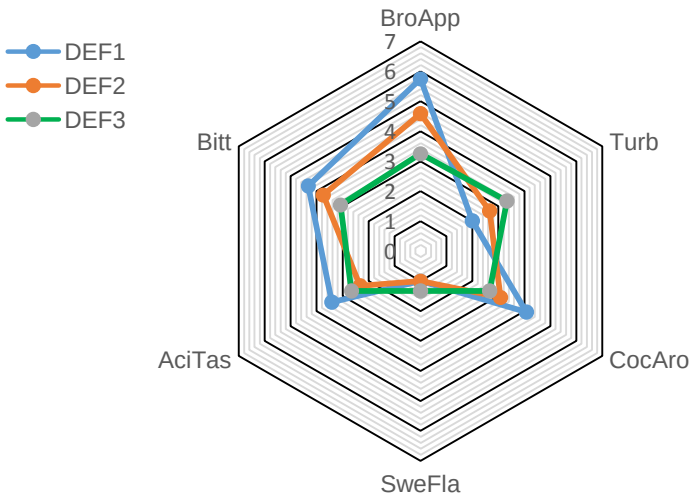

Figure 1: Sensory profiles of diluted cocoa extract formulations

DEF1, ***DEF2***, ***DEF3***: *extract formulations for respective dilutions 1/3, 1/5 and 1/8.* ***BroApp***: *brown appearance;* ***Turb***: *Turbidity;* ***CocAro***: *Cocoa Aroma;* ***SweFla***: *Sweet Flavor;* ***AciTas***: *Acid Taste;* ***Bitt***: *Bitterness*

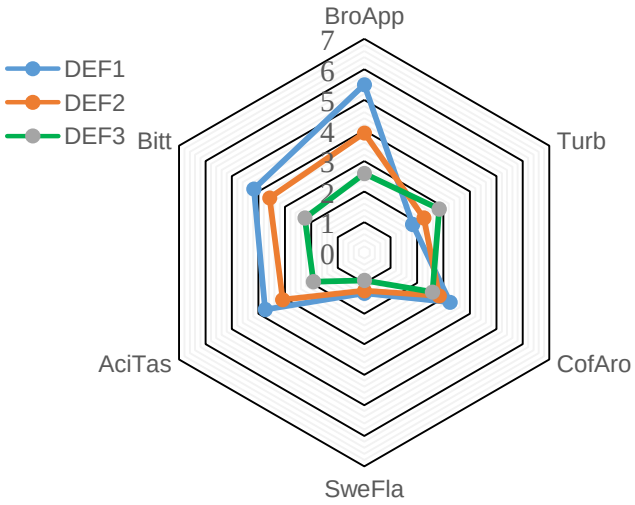

Figure 2: Sensory profiles of diluted coffee extract formulations

DEF1, ***DEF2***, ***DEF3***: *extract formulations for respective dilutions 1/5, 1/10 and 1/20.* ***BroApp***: *brown appearance;* ***Turb***: *Turbidity;* ***CofAro***: *Cocoa Aroma;* ***SweFla***: *Sweet Flavor;* ***AciTas***: *Acid Taste;* ***Bitt***: *Bitterness*

3.1.3 Sensory acceptance of diluted extracts of cocoa and coffee

The sensory acceptance is statistically different ($P<0.05$) from the diluted cocoa and coffee extract formulations studied. Panellists have enjoyed the cocoa extract dilution 1/8 at the rate of 48.33% against 46.66% and 38.66% acceptance for respective dilutions 1/5 and 1/3 (table III). However, the investigation also shows indecisive panellists opinions scores of 28.33%, 10%, and 11.33% and rejections scores of 23.33%, 43.33%, and 50% from respective cocoa extract dilutions 1/8, 1/5, and 1/3.

Similarly, the sensory acceptance of the diluted coffee extract formulations have been more rate from the greatest dilution (1/20) with 50% panellists, against 36.66% panellists for rejections and 13.33% for indecisive opinions. The coffee dilutions 1/5 and 1/10 have recorded respective 43.33% and 43.32% acceptance (table IV).

3.1.4 Sensory variability of diluted extracts of cocoa and coffee

The principal components analysis (PCA) have shared the sensory descriptors around five components (F1 to F5). From these distribution, both F1 and F2 components given respective eigenvalues of 4.23 and 1.30 are considered for drawing the main variability design, since they support over 92% of total variance (table V). Indeed, the F1 component ensures over 70% total variance and is more significantly built with the brown appearance, turbidity, specific cocoa or coffee aroma, acid taste and bitterness of the diluted formulations. Oppositely, the F2 component displays 21.61% total variance and is mainly given the sweet flavor of the cocoa and coffee formulations.

From the F1-F2 factorial design, the PCA displays correlations between the sensory descriptors and the formulations samples (figures 3A and 3B). Thus, the F1 component shows significant negative correlation with the cocoa or coffee aroma, the brown appearance, the bitterness, and the acid taste. These sensory traits are more rated from cocoa and coffee formulation by respective dilutions 1/3 and 1/5. On the other hand, the cloudy appearance (turbidity) is positively correlated with the F1 component and is mostly mentioned from cocoa and coffee formulations by respective dilutions 1/10 and 1/20. However, the F2 component is most significantly given the sweet flavor, especially from the coffee extract formulation at the dilution 1/10.

3.2 Discussion

The sensory analysis of the diluted extracts formulations (DEF) of cocoa and coffee has been achieved on the brown appearance, specific cocoa or coffee aroma, turbidity, and flavors (sweet, acidic and bitter) of these drinks.

The brown appearance, the deeper cocoa aroma, the acid taste, and the bitterness were felt in more intensive tenses from the lowest cocoa extract dilution (DEF1 or dilution 1/3), compared to both dilutions 1/5 and 1/8. The cocoa DEF1 is a low diluted formulation and records greater concentration of the main cocoa compounds recovered from the raw extract, compared to the other formulations prepared. Thus, the more the biochemical components the more the perception of organoleptic traits from the food product. Cocoa DEF1 could also contain more antioxidant pigment compounds involving in the brownish appearance **[14]**.

Many compounds such as secondary metabolites, free amino acids, peptides, and reducing sugars deriving from the hydrolysis of proteins and carbohydrates are of the main precursors for cocoa flavors and aroma **[15]**. These sensory parameters are exhibited accordingly to the dilution rate.

Table III: Percentage of panelists according to their acceptance preferences of the diluted extract formulations of cocoa

Rating scale		1	2	3	4	5	6	7	8	9	X²	P-value
General trend		Rejection				IO			Satisfaction			
Theoretical rates (%)		11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11		
Formulations	cocoa DEF1	3.33	11.66	10	25	11.66	21.66	15	0	1.66	53.52	<0.001
	cocoa DEF2	0	3.33	10	30	10	26.66	15	3.33	1.66	85.52	<0.001
	cocoa DEF3	0	1.66	13.33	5	11.66	36.66	13.33	8.33	1.66	123	<0.001

DEF1,2,3: diluted extract formulation for respective dilutions 1/3, 1/5 and 1/8; IO: indecisive opinion scores; F: formulation; X^2: value of statistical Chi 2 test; P-value: probability value of the statistical test; P-value <0.05 express statistical significant differences of the percentages.

Table IV: Percentage of panelists according to their acceptance preferences of the diluted extract formulations of coffee

Rating scale		1	2	3	4	5	6	7	8	9	X²	P
General trend		Rejection				IO			Satisfaction			
Theoretical rates (%)		11.11		11.11	11.11	11.11	11.11	11.11	11.11	11.11		
Formulations	coffee DEF1	1.66	16.66	10	20	10	20	18.3	6.6	0	39.5	<0.001
	coffee DEF2	1.66	5	13.33	23.33	13.33	21.66	11.66	8.33	1.66	44.49	<0.001
	coffee DEF3	0	1.66	10	25	13.33	30	13.33	5	1.66	80.99	<0.001

DEF1,2,3: diluted extract formulation for respective dilutions 1/5, 1/10 and 1/20; IO: indecisive opinion scores; F: formulation; X^2: value of statistical Chi 2 test; P-value: probability value of the statistical test; P-value <0.05 express statistical significant differences of the percentages.

Table V: Data of the sensory variability of the diluted extract formulations of cocoa and coffee recorded from the principal components analysis

Components	F1	F2	F3	F4	F5
Eigen- values	4.23	1.30	0.34	0.12	0.02
Variance (%)	70.47	21.61	5.67	1.97	0.28
Cumulated variance (%)	70.47	92.08	97.75	99.72	100.00
Brown Appearance	**-0.97**	0.12	-0.12	0.12	-0.10
Turbidity	**0.86**	-0.12	-0.49	-0.04	-0.01
Specific Aroma	**-0.86**	0.42	-0.21	-0.20	0.01
Sweet Flavor	-0.23	**-0.97**	-0.07	-0.01	-0.01
Acid Taste	**-0.91**	-0.38	0.08	-0.17	0.00
Bitterness	**-0.96**	-0.03	-0.19	0.18	0.08

The cocoa aroma, acid taste and bitterness were more intensively felt in DEF1, since this formulation records little dilution rate than DEF2 and DEF3 formulations. The great bitterness trend is due to a high concentration of polyphenols and alkaloid compounds such as theobromine, quinine or caffeine. The dried cocoa beans are originally considered bitter. At this level, our results are not in conformity with those of Soro **[16]**.

Indeed, this author found that TMF reduced greatly the phenolic load and therefore the astringency of cashew apple juice. He concluded that the agglomerated polyphenols are retained while the free polyphenols are not. The bitterness of the cocoa and coffee formulations samples means that the polyphenol compounds are mostly free but not in significant aggregation trend with other molecules. The low expression of the acid flavor may be due to the fair roasting process leading to significant decrease of the acidity by evaporation of volatile acids like acetic acid as attested by previous reports **[17]**. As for turbidity, its average perception could be explained by an insufficiency in the use of TMF **[16]**.

However, the feeling of cocoa aroma could be strengthened by others processing conditions as the raw cocoa beans fermentation, the roasting, and the use of tangential microfiltration (TMF) during the raw extract recovery as mentioned by Beckett **[17]** and Soro **[16]**. According to these authors who work on various juices, the use of baromembrane processes often leads to the drop of the content regarding specific cocoa aroma substances in the final extract.

With any obvious change of the sweet taste from cocoa formulations, the main sweet compounds, namely carbohydrates, could globally record similar contents within. In addition, the sweet flavor has not been felt in rather rate since raw dried cocoa beans aren't originally sweet product and sweetness is not enhanced nor settled by technological processes of the sole cocoa powder **[17]**.

Among these three cocoa samples, the cocoa DEF3 (dilution 1/8) is mostly enjoyed (48.33% acceptance), may be due to rather light specific cocoa aroma and brown appearance. The Cocoa DEF3 could therefore be subjected to extensive analyses for better valorization.

For coffee, the descriptors retained are: brown appearance, specific coffee aroma of, turbidity and flavors (sweet, acid and bitter). The coffee DEF1 (dilution 1/5) was felt more significantly sombre due to the low water added for dilution compared to coffees DEF2 and 3 (dilutions 1/10 and 1/20). Roasted and ground coffee naturally get sombre appearance by

compounds resulted from the Maillard reaction **[18]**. Such compounds, and also other antioxidant pigments are more concentrated in low diluted coffee DEF1.

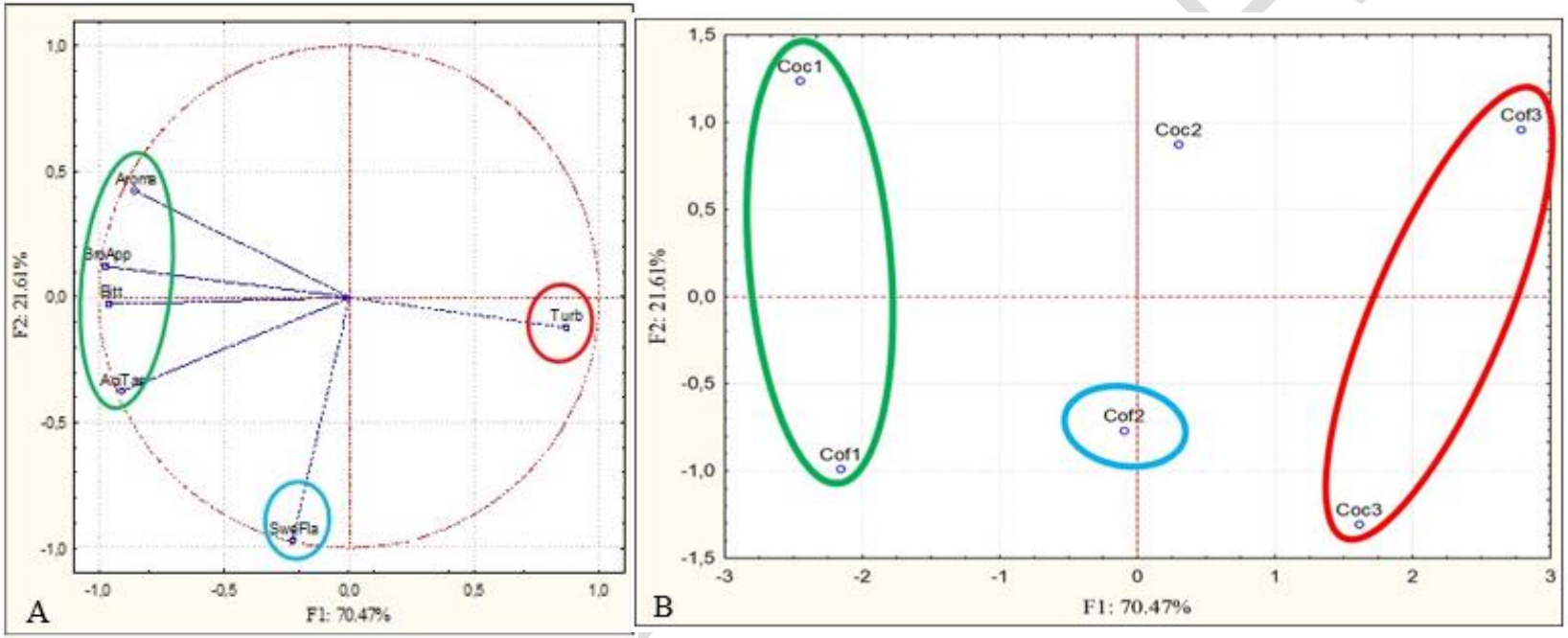

Figure 3: Distribution of the sensory descriptors (A) and the cocoa and coffee formulations (B) studied according to the F1-F2 factorial draw of the Principal Components Analysis (PCA).

Aroma: Specific aroma; BroApp: Brown Appearance; Bitt: Bitterness; AciTas: Acid Taste; SweFla: Sweet Flavor; Turb: Turbidity; Coc1, 2, 3: cocoa extract dilutions 1/3, 1/5, 1/10; Caf1, 2, 3: Coffee extract dilutions 1/5, 1/10, 1/20.

According to Hervert-Hernandez et al. **[14]**, several plant species exhibit a wide range of phytochemicals with well-known antioxidant properties. The presence of antioxidant pigments could therefore justify the sombre appearance of coffee extracts. The membrane processes used did not significantly affect the coffee extract colour **[16]**.

The acid and bitter flavors are due to the presence of chlorogenic, aliphatic, and nicotinic acids and quinines but also of nitrogenous compounds (caffeine, trigonelline). Thus, they contribute to the bitterness and acidity of the coffee. According to Tice **[19]**, these compounds are the precursors of phenols and catechols which are developed during roasting and can give a pleasant or unpleasant taste to the coffee. They also have an aperitif power and stimulate the secretion of saliva and gastro-intestinal juices needed for digestive functions **[20]**. Consumption of the coffee extract is friendly with the organic acids' advantages. Likewise, numerous studies have demonstrated the beneficial effects of coffee consumption on health, mainly antioxidant and anti-carcinogenic activity **[21]**. Polyphenols are the most abundant antioxidant compounds in the diet. Daily consumption of 3 to 4 cups of coffee could fill the recommendation of 1 g polyphenols taught by FAO **[22]**.

The differences observed between the samples studied are due to the dilution rate. Higher dilution range involve low feeling of acidic and bitter flavours. The membrane processes used have no effect on the contents of polyphenols and free alkaloids and therefore on bitterness and acid flavour **[16]**.

The sweet flavor, coffee aroma, and turbidity didn't induce any statistical difference between formulations. The sweet taste and coffee aroma are lightly felt by tasters in overall samples studied may because of the bitterness and acidity of the various coffee solutions. Such results could have been defaulted by the roasting process. According to Guyot **[23]**, carbohydrates account for over 50% dry matter of green coffee and are changed into aromatic compounds by the roasting. Clarke et al. **[24]** reported the involvement of trigonelline for the coffee aroma through chemical change into nicotinic acid during roasting. Thus, any aroma could not be produced without roasting the green coffee. In addition, the low perception of the aroma may be due to the TMF that has been previously claimed to retain some agglomerated aromatic compounds in the insoluble phase (oil cake) from cashew apple juice **[16]**. The use of TMF otherwise eliminates micron-size particles and organisms and therefore leads to homogenous and clear product, hence it's known as a "clarification process".

The coffee DEF3 (dilution 1/20) recorded the highest acceptance index (50%), thanks to the moderate exhibition of brown appearance and bitter and acid flavors that partially hide the sweetness of the coffee drink. Thus, the dilution rate at 1/20 processed from raw coffee TMF extract could be subjected further investigations for better valorization.

4. CONCLUSION

The sensory profiles of the diluted cocoa and coffee extracts formulations and their acceptance rate were investigated. The formulations at dilutions 1/20 and 1/8 for respective coffee and cocoa extract are more enjoyed. They displayed clear-brownish appearance, limpid aspect, sweet taste hardly pronounced, weak acidic flavor, moderate aromas, and moderate bitterness. Both drink formulations could be technological support for further investigations in view of the development completion of the food extracts.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. 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.

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