Symbiosis

www.symbiosisonline.org
www.symbiosisonlinepublishing.com
ISSN Online: 2372-0980

Research article | Journal of Nutritional Health & Food Science | Open Access

Valorization of Pepper (*Capsicum Chinenses Linn*) Through Formulation and Production of Ready to Use Cubes from Cameroonian Local Spices

Kensah Marianne Mugob Bonyesih[1], Mezajoug Kenfack Laurette Blandine[2*], Ngangoum Eric Serge[3], DjiazetStève[4], Tchiégang Clergé[5]

[1,2,3,4,5]Bioprocess Laboratory, Unit of Food Sciences and nutrition, University Institute of Technology, University of Ngaoundere, Cameroon P.O. Box 455, Ngaoundere - Cameroon

Received: April 12, 2018; Accepted: November 9, 2018; Published: November 15, 2018

***Corresponding author:** *Mezajoug Kenfack Laurette Blandine, Bioprocess Laboratory, Unit of Food Sciences and nutrition, University Institute of Technology, University of Ngaoundere, Cameroon P.O. Box 455, Ngaoundere – Cameroon, Tel: +237 697 920 434/ +237 677 920 403, E-mail: mezajouglaurette@yahoo.fr*

Abstract

In Cameroon, pepper is consumed either fresh, in powder form, as pepper oil or as pepper sauce. The aim of this work was to propose added value of spices by formulated ready to use cubes facilitating the consumption of pepper and reducing its post-harvest losses. A survey was carried out in Ngaoundere-Cameroon to know the level of pepper consumption, and the ingredients commonly added in pepper sauces. A simplex lattrice mixture design was carried out to optimise the pepper cube formulation, which was further characterized. The sensory evaluation was done to select the best sample among those produced. From the survey, 76.92% of the population consume pepper. Onion, garlic, white pepper, and *pebe* were found to be the spices commonly used along with pepper sauces preparation. The pepper cubes were obtained by incorporating onion and *pebe* as additives into the pepper enrichment at different proportions. The pepper enrichment was formulated at the optimal condition of the basic ingredients which were 0.817, 0.133 and 0.05% respectively for pepper, white pepper and garlic. Sample 107 with the colours ranging between orange yellow and yellow, made up of 50 % pepper enrichment, 32.5% onion and 17.5% *pebe* was selected through sensorial analysis by the panellist as the best specimen. This retained product exhibited about 50% of DPPH scavenging activity compare to ascorbic acid taken as control.

Key words: Cameroon; Pepper; spices; formulation; cube; antioxidant;

Introduction

The increase in the size and proportion of urban population raises the demand for food and hence the need for urban agriculture [1]. In view of contributing to the nation's industrial and economic growth through innovation while maintaining quality and satisfying consumer needs, pepper (*Capsicum chinenses*) was the local product of interest since consumers nowadays demand high quality foods having 'fresh' or 'natural' characteristics but requiring a minimum amount of preparation [2]. Pepper is a perishable fruit which starts life green but turns red, orange, yellow or purple as they ripen upon maturation and it was ranked the second valuable fruit after tomatoes with an estimated total production of 88,000 metric tons in 2011 [3, 4]. Capsicums are important food additives in many parts of the world, valued for their sensory attributes of colour, pungency and aroma [5]. Consumers with their many choices regarding food supply tend to be very selective about the products they purchase and hence demand a wide variety of products that are of high quality and offer nutritious and good value [6]. As a result, they tend to get interest in the relationship between diet and health which causes them to utilize nutrient content and health claim information from food labels to make their purchase choices. As a consequence, industries have now been involved in the production of formulated products that are obtained by associating and mixing diverse raw materials from either natural or synthetic origin in order to produce foods that meet the demands of these consumers and as well remain in the market [6, 7]. But formulation in food industries as reported by Jean-Marie and Gilbert makes use of mostly ingredients from natural origin in order to increase the performance of a product while enhancing conservation and utilization [7]. In the same line, it is necessary to give an added value to some local ingredients (garlic, onion, *pebe* and white pepper) through the formulation of pepper (*Capsicum chinenses*) cubes in order to improve its performance and flavouring attributes.

Due to carotenoids, ascorbic acid, tocopherol, and other phytochemical contents pepper consumption can reduce the risk of diseases, such as arthritis, cardiovascular disease, cancer and also delaying the aging process [8-10]. The major preservation forms of this fruit are pepper powder, pepper oleoresin (pepper oil) and preservation in acid brine [11-13]. To our best knowledge pepper preservation in the cube form have not yet be done, hence *C. chinenses* cultivar was chosen with the aim of giving it an added value through the diversification of the product's availability and the enhancement of its preservation techniques since it is perishable; lasting only for a few days after harvest and still decaying upon refrigeration [11, 14]. Therefore the main objective of this work was to diversify the preservation technique

 ***Corresponding author email:** *mezajouglaurette@yahoo.fr*

and valorise pepper by adding value to white pepper, garlic, onion and *pebe*. Firstly, formulated fresh pepper cube with white pepper, garlic, onion and *pebe* was done, followed by evaluation of the nutritional and sensory properties of the cube and finally determined the antioxidant properties of the end product.

Materials and Methods

Materials

The studied materials used were pepper, white pepper, garlic, onion and *pebe.* Table 1 presents the samples names, their family, the forms and parts in which they were used

Sampling

Fresh yellow pepper as a major component of the formulation was harvested from a farmland at Boussiraiat about 45 Km from Ngaoundere (Adamawa Region, Cameroon). Pebe, White pepper, Garlic and Onion was bought from a local market in Ngaoundere. The origins of pebe and white pepper were Yokadouma (East Region) and Penja (Littoral Region) respectively, while garlic and onion were from Garoua (North Region). Picture 1 shows the different samples before processing.

Table 1: Presentation of the names, family and part of the biological materials used

Samples (scientific name)	Samples (common name)	Family	Forms and Parts used
Capsicum chinenses L.	Pepper	Solanaceae	Dried fruits
Monodora myristica G.	Pebe	Annonacea	Dried kernels
Piper nigrumL.	White pepper	Piperaceae	Dried berries
Allium sativum L.	Garlic	Liliaceae	Fresh bulbs
Allium cepa L.	Onion	Liliaceae	Fresh bulbs

Picture 1a: *Allium cepa* (Onion)

Picture 1b: *Allium savitum* (Garlic)

Picture 1c: *Capsicum chinenses* L. (Pepper)

Picture 1d: *Monodora myristica* (Pebe)

Picture 1d: *Piper nigrum* (White pepper)

Pictures:

Methods

Scheme of work

The realization of the set objectives for this work was made possible through a sequential advancement as represented on figure 1.

Preparation of the Samples

The studied samples were prepared according to their nature and base on the unit operations which are briefly explained as fellow:

Picture 2: Spiced pepper cube

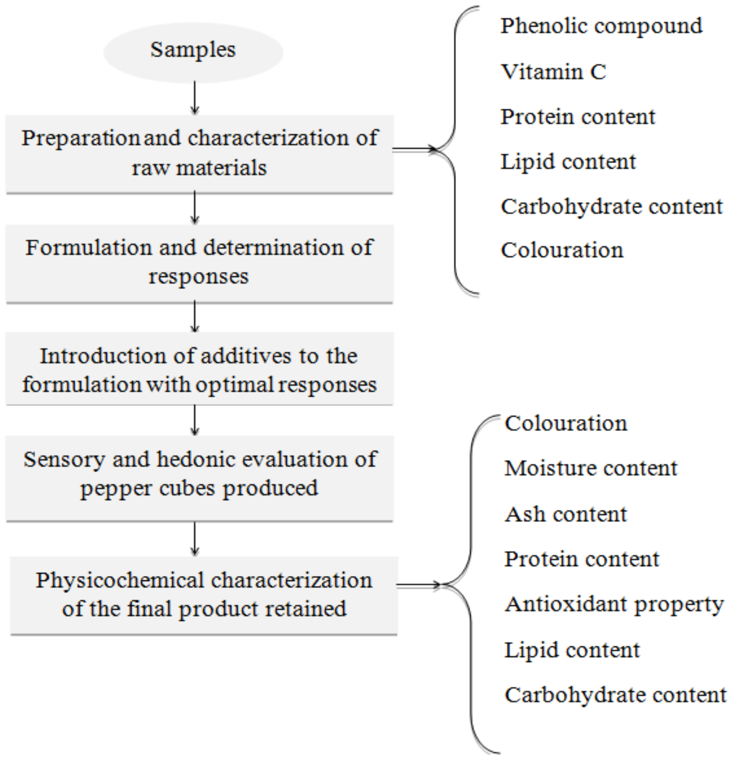

Figure 1: Synoptic diagramof the work done

Sorting: The raw materials (fresh yellow peppers, *pebe*, white pepper, garlic and onion) were carefully selected manually. Sorting of the yellow pepper was to remove immature fruits, insect infected and spoiled fruits. White pepper and *pebe* were sorted to eliminate debris and stones as well as spoiled grains and nuts respectively. Dried, infected and/or decayed garlic and onion bulbs were removed from the samples.

Washing: The peduncles of the good fruits of the yellow pepper were further removed and the fruits washed and rinsed with distilled water. Also, good garlic and onion bulbs were washed using distilled water to avoid product contamination.

Drying: The whole pepper fruits after washing were dried at 55°C in a ventilated oven for 7 days. The whole fruits were dried in order to reduce discolouration and oxidation of carotenoids as well as the oxidation of fats, proteins and capsaicin found in the seeds. It has been shown by that the colour of crushed or ground chilli powder deteriorates faster upon drying than whole chilli, due to the auto-catalyzed degradation of carotenoids [15].

Dehulling: *Pebe* nuts were dehulled manually and the shells removed. The nuts were then ground.

Grinding: *White pepper, pebe*, garlic and onion and the dried whole pepper were further ground using a ZAIBA® blender with model number ZB-2255, China.

Sieving: The ground samples were then sieved using an Analysensieb 500 µm sieve with model number 305714 to obtain particle sizes of less than or equal to 500 µm.

Peeling: Garlic and onion were peeled and the peels discarded. They were ground immediately after washing and prior to mixing to prevent oxidation and discolouration.

Mixing: White pepper, Garlic and pepper were mixed with the help of a blender to obtain a pepper enrichment on which preliminary tests were carried out. Onion and *pebe* were further being added to the enrichment and mixed thoroughly to obtain spiced pepper enrichment.

Moulding: The spiced pepper enrichment obtained after mixing was then formed into desired shapes and preserved in the refrigerator to increase the product's shelf life.

Survey on Pepper Consumption

The investigation of pepper consumption was carried out with women with ages range from 25 to 70 years old, who are the main marketers, processers, buyers, and users [16]. In this investigation, information concerning forms of preservation, spices used and appreciation of a new form of pepper preservation in the town of Ngaoundere-Cameroon were collected. The information was collected from sixty five (65) women chose randomly. The investigation was carried out with the aim of knowing the types of spices commonly used by women, as well as quantifying the proportions of these spices so as to properly situate the lower and upper intervals for the mixture design. With the help of a questionnaire, the women were being asked questions and their responses noted to the corresponding question.

Formulation for Pepper Cubes

The production of pepper cubes using five components required a mixture of these components in appropriate proportions so as to obtain a homogeneous mixture equivalent to 100%. Each constituent had a percentage that depended on the others as described by Goupy and Creighton that when the quantity of one constituent increases the other reduces [17].

The experimental domain of the major component (pepper) was set as 70-85% while white pepper and garlic had as domains 10–25% and 5-20% respectively. All parameters were coded as 0 for lower limit and 1 for upper limit. Minitab 14 was used as software to generate the experimental matrix for the formulation and analysis of experimental data. Table 2 clearly shows the experimental matrix where X_1 represents pepper, X_2, White pepper and X_3 is garlic given as pseudo-components, while Table 3 indicates the same parameters in reel values. Ten experiments were carried out in order to define the optimum proportions of the basic components (pepper, garlic and white pepper) using

Table 2: Varying proportions of pepper, white pepper and garlic as pseudo-components

Runs	X1	X2	X3
1	0.000	1.00	0.000
2	0.167	0.667	0.167
3	0.000	0.000	1.000
4	0.667	0.167	0.167
5	0.500	0.500	0.000
6	0.000	0.500	0.500
7	0.500	0.000	0.500
8	0.333	0.333	0.333
9	0.167	0.167	0.667
10	1.00	0.000	0.000

Table 3: Varying masses (g) of pepper, white pepper and garlic during formulation

Trials	X_1	X_2	X_3	Vitamin C (Vit C)
1	0.700	0.250	0.050	Vit C_1
2	0.725	0.2	0.075	Vit C_2
3	0.700	0.100	0.200	Vit C_3
4	0.800	0.125	0.075	Vit C_4
5	0.775	0.175	0.050	Vit C_5
6	0.700	0.175	0.125	Vit C_6
7	0.775	0.100	0.125	Vit C_7
8	0.750	0.150	0.010	Vit C_8
9	0.725	0.125	0.150	Vit C_9
10	0.850	0.100	0.050	Vit C_{10}

vitamin C content as response. Vitamin C content was chosen as response because it is an antioxidant component and stands as an indicator for antioxidant activity for the final product. It is also very unstable and capable of undergoing modifications during transformation since it is sensitive to heat, light and oxygen.

Enrichment and Production of Spiced Pepper

The desired cube product defined as a mixture spices is to have a high vitamin C, phenolic compound contents so as to give to the product a high antioxidant property. In view of obtaining a product with expected characteristics, onion and *pebe* were used as additives in different proportions. According to Vaclavik and Christian, food additives are substances or a mixture of substances other than a basic foodstuff, added to foods for specific physical or technical effects [18]. Onion was used in greater quantities than *pebe* because of the technical advantage i.e. its high moisture content was used to humidify the powders so as to facilitate moulding upon compression. *Pebe* was chosen and used to improve the aroma of the pepper cube since the kernels possess very strong aroma as reported by Enwereuzoh, et al. [19]. The desired mass for the cubes was 10 g and table 4 represents the different proportions of the two ingredients which were introduced as additives in 50% of pepper cube. Therefore, as shown in table 4, the masses of these chose additives were varied from 3-4g for onion and from 1-2 g for *pebe* while the mass of the enriched pepper was kept at 5 g.

Production process of pepper cubes

The production of pepper cubes was done using five local ingredients and following a sequential step as shown on figure 2 and 3, which clearly outlines the unit operations during the production.

Table 4: Varying masses (g) of onion and pebe in different formulations

Range	Pepper enrichment	Onion	Pebe
Sample A	5.00	3.00	2.00
Sample B	5.00	3.25	1.75
Sample C	5.00	3.50	1.5
Sample D	5.00	3.75	1.25
Sample E	5.00	4.00	1.00

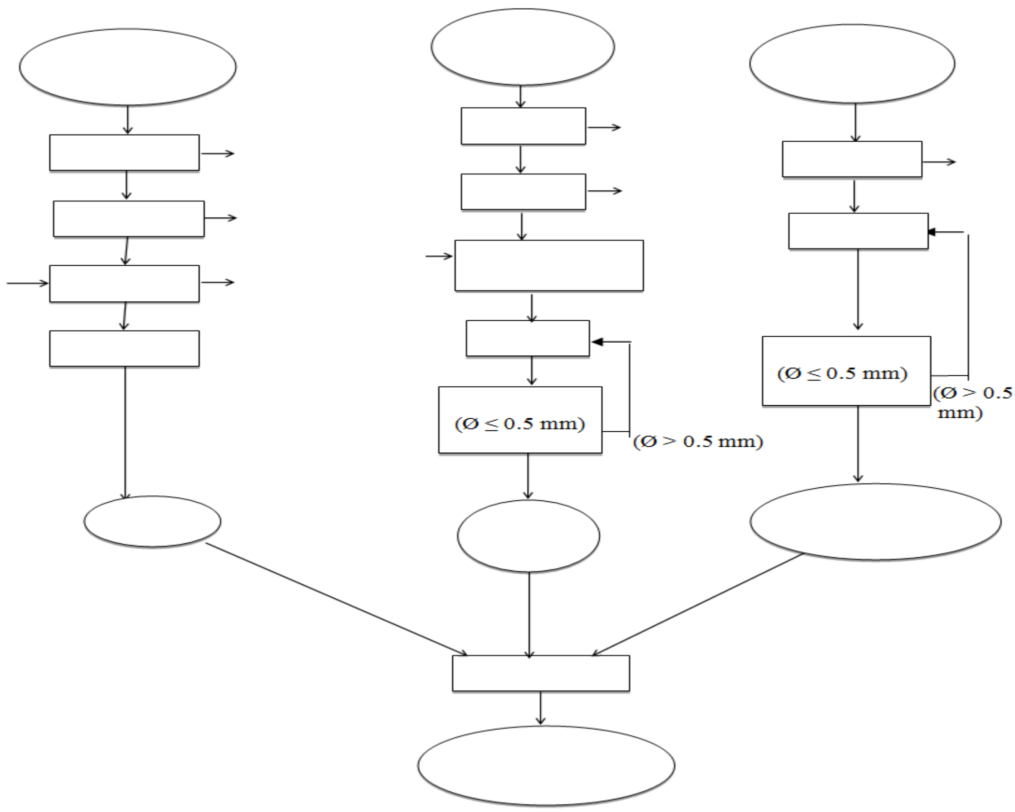

Figure 2: Production process of spiced pepper paste

Citation: Mezajoug Kenfack LB, Mugob Bonyesih KM Eric Serge N, et al. (2018) Valorization of Pepper (*Capsicum Chinenses Linn*) Through Formulation and Production of Ready to Use Cubes from Cameroonian Local Spices J Nutrition Health Food Sci 6(6):1-14. DOI: 10.15226/jnhfs.2018.001147

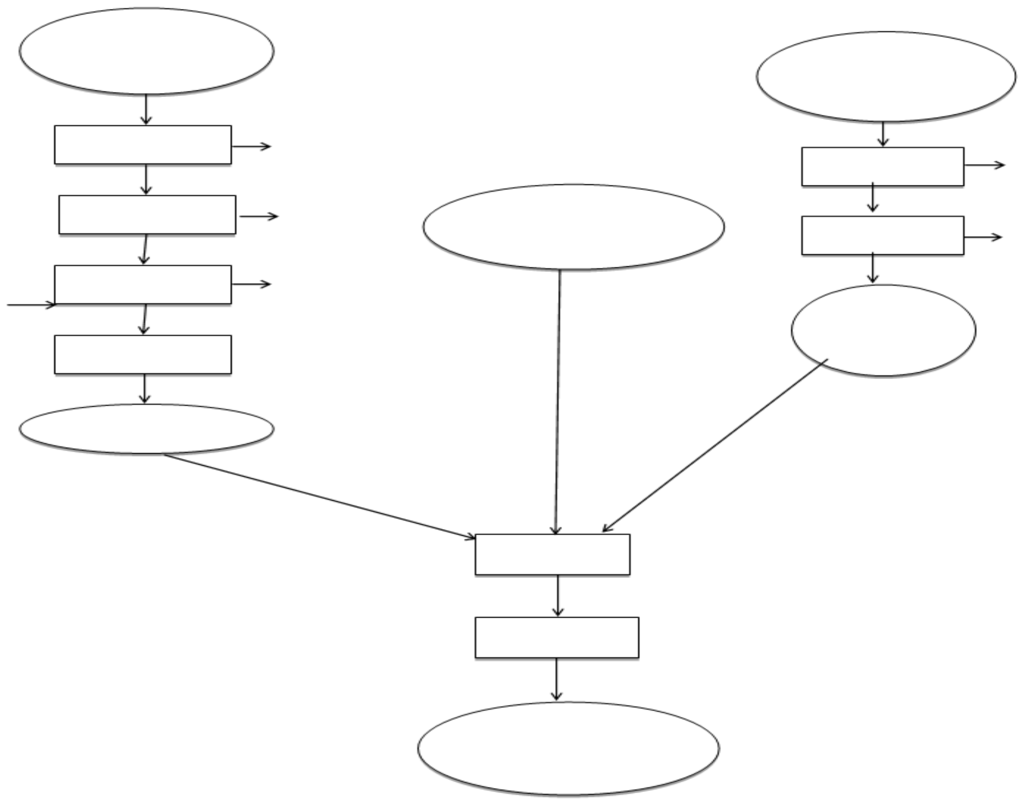

Figure 3: Production process of spiced pepper cubes

Physicochemical Characterization

Chemical Analyses

Dry Matter and Ash Content of the Samples

The determination of the dry matter of samples was done using the AFNOR method and the ash content was performed using the method described by AOAC [20, 21].

Total Proteins, Lipids and Carbohydrate Content

The total nitrogen was determined after mineralization of the samples according to the Kjeldahl method, using boric acid solution in the presence of an indicator as described by AACC [22]. The total nitrogen was then converted into total protein content by multiplying with 6.25 as conversion factor. The total lipids were extracted using the Soxhlet extractor as described in the Russian method described by Bourely [23]. Total carbohydrate contents were estimated by difference between the sum of other major nutrient components (protein and fat) and moisture content according to FAO using the following formula [24]: Total Carbohydrate contents (%) = 100 – (% [protein + fat + moisture content])

Determination of Vitamin C and Total Phenolic Contents

The vitamin C content was determined by the official AOAC titrimetric method using the 2, 6 Dichlorophenol indophenols [25]. While the crude total phenolic compounds were extracted with 70% ethanol and then assessed with the Folin - Ciocalteu reagent as described by Marigo [26].

DPPH Radical Scavenging Activity Assay

The antioxidant activity was determined by the capacity of a component to trap a free radical or to give an atom of hydrogen according to the method described by Zhang and Hamauzu with some modifications [27]. 2 ml of freshly prepared DPPH solution (0.1 mM prepared in methanol) was introduced into a test tube containing 0.5 ml of sample extract. The mixture was thoroughly mixed for 5 min and incubated in darkness for 30 min at ambient temperature (25°C). For the control tube, methanol was used in the place of the sample extract. Ascorbic acid was used as positive control, the methanol replacing the sample extract, was used as the negative control. The absorbance of the resulting solution was read at 517 nm, and the antioxidant activity of the sample extracts was calculated as follow:

Scavenging Activity effect (%) =100× $(A_{control}–A_{sample})/A_{control}$

Physical analyses: Colour determination of pepper cube

The colour of the cubes was determined using the CIE L, a, b coordinates L*, a* and b*, where L*, a* and b* values were recorded, with L* indicating lightness (+) or darkness (-), a* indicating red (+) or green (-) and b* indicating yellow (+) or bleu (-).The three values are needed to completely describe the colour of an object [28].

The samples were placed on a clean white paper and introduced in a wooden box for image acquisition. The image was introduced in the computer for pre-processing, segmentation and colour conversion from RGB to Lab space, using the ''Image J'' software. The measurements were made directly on the top (upper) surface, which was always steady, of cylindrical samples and the L*, a* and b* values were recorded. The color intensity (C) and the hue angle (hab) were calculated using the formulas below:

$$C = \sqrt{a^{*2} + b^{*2}}$$

$$h_{ab} = \tan^{-1}(b^*/a^*)$$

Sensory analysis and hedonic evaluation

Descriptive sensory analysis is the sensory method chosen because it enables discrimination between a range of products based on their sensory characteristics and it also enables panelists to identify and quantify a product's sensory properties [29]. Hedonic evaluation was also done according to method described by Aka Boigny *et al.* [30] with some modifications to determine the degree of consumer acceptance or preference. For this evaluation 12 panelists were randomly chosen based on their frequency and their awareness in pepper consumption and use. They were sensitized on the objective of the sensory analysis. They were also ready to undergo and how they were expected to fill the form based on their sensory judgments. Five pepper cube samples with different varied proportions in additives and different codes were presented to each panelist and potable water, bread was provided to them also for chewing and rinsing of the mouth after each sample. A 9- point scale form that ranged from (9)-like extremely to (1) disliked extremely was given to each panelistto record their opinion to assess appearance (colour), shape, size, flavour, friability, and the overall acceptability of the product. The radar plot was used to represent the panelist view of each sensorial characteristic of the product.

Results and Discussion

Survey on pepper consumption

A survey was carried in Adamawa region of Cameroon. Sixty five women were sampled with the aim to know the level of pepper consumption, the colour of peppers used and the spices used during preparation. Out of the sampled population, it was essential to know the consumption rate of pepper and figure 4 shows the consumption level of pepper where 76.92% of the sampled population consume pepper and 23.08% do not. Out of this percentage, 70% use pepper directly in food during cooking while 30% consume as accompaniment. This finding is in-line with studies shown by Tchiégang et al. [12] in Cameroon that pepper is used directly as a spice in human nutrition or indirectly (as accompaniment) after transformation. These choices of pepper consumption can be explained by the fact that cooking directly in food saves time and gives an additional flavour to food.

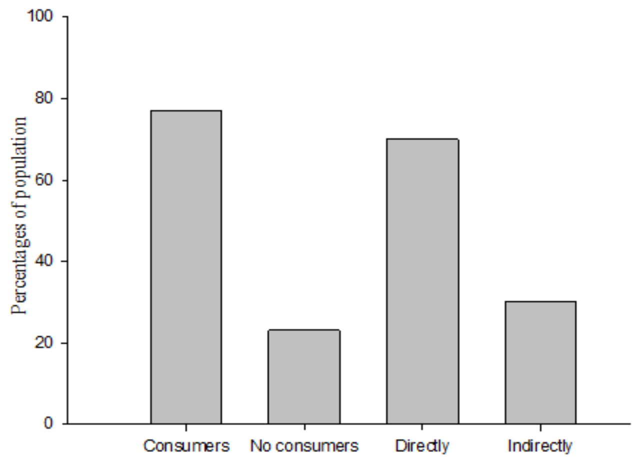

Figure 4: Representation of pepper consumers and non-consumers of pepper from the sampled population

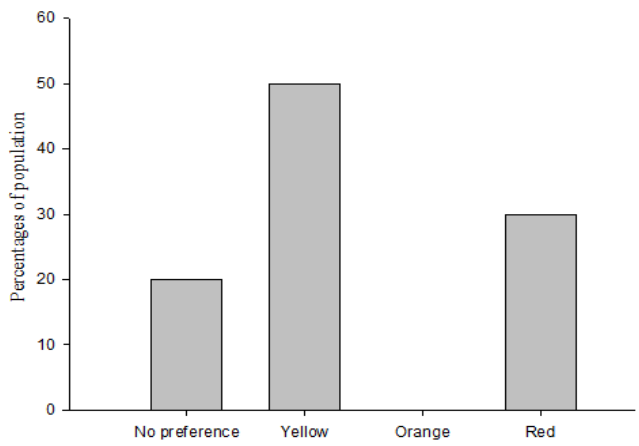

Figure 5: Representation of the colours of pepper chosen by consumers

Out of the individuals who consume pepper, 85.71% of them were found to consume pepper in its fresh form and 11.43% use the powder form to cook. While 2.86% go for both the powder and the fresh forms. These forms of pepper consumption chosen confirms studies that were done by Segnou *et al.*[31] Which states that pepper fruits are consumed fresh or dried either as whole fruit or ground? The preference for the fresh form is due to its availability, accessibility and reduced pungency according to Ozgur et al.[32] Which stipulates that dried foods are more concentrated than fresh foods? Figure 5 shows that 50% of the sampled population prefers yellow colour 30% preferred colour while 20% has no particular preference. The yellow colour is consumed more than the orange and red colours. This can be due to the fact that the population desires pepper with mild pungency and orange peppers are not popular in Cameroon. In fact Tchiégang and Ngassoum reported in Cameroon that yellow peppers are less pungent than red peppers [11].

In order to know which ingredients are used along with pe pper during peppersauce preparation, the sampled population were interrogated. Figure 6shows the ingredients commonly used by the women during the preparation of their pepper sauces Figure 6 indicates that, onion, garlic, pebe and white pepper are the ingredients commonly used by women during pepper sauce preparations. Chemical properties of raw materials

Chemical properties of raw materials

The results obtained after analysis of the five raw materials (pepper, white pepper, pebe, garlic and onion) used during the production of pepper cube sare presented in table 5.

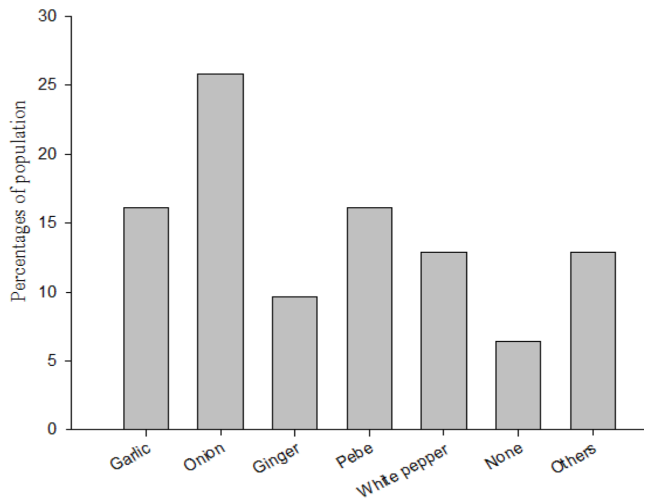

Figure 6: Representation of the ingredients used during the preparation of pepper sauce

Table 5: Chemical composition of raw materials (% of fresh weigh)

Composition	Ingredients				
	Pepper	White pepper	Pebe	Garlic	Onion
Moisture content (%)	17.34±0.37	17.60±1.00	11.66±0.32	76.06±0.32	92.16±0.72
Vitamin C (mg)	12.88±1.98	6.52±0.77	28.54±1.06	1.07±0.45	1.75±0.41
Phenolic compounds (mg)	12.76±1.50	4.42±0.47	5.36±0.63	1.37±0.46	1.46±0.14
Lipids (%)	4.15±0.04	5.23±0.35	9.60±0.02	0.42±0.05	3.26±0.04
Proteins N x 6.25 (%)	19.90±0.71	15.75±1.93	24.45±4.71	18.73±0.56	3.62±0.04
Carbohydrate (%)	58.61	61.40	54.29	4.79	0.96

Vitamin C contents

The vitamin C content for pepper was 12.88mg/100 g which is in line with the range of 12.0 to 44.4 mg/100 g [33] for red varieties but lower than that of dried chilli (26 mg/100 g) [34]. This difference can be due to the sensitivity of this vitamin to oxidation upon drying and exposure to light during grinding as well as the maturity, growth conditions and cultivar. It has been reported that factors such as genotype, environment and fruit maturity affect the ascorbic acid content [35, 36].

Crude phenolic compounds

The crude phenolic compound for pepper was calculated and obtained as 12.76 mg/100g which was the highest value recorded for this parameter. Pebe, white pepper showed a slight variation with 5.36 mg/100 g and 4.42 mg/100 g being the values recorded for these ingredients. Onion and garlic presented the least values of 1.46 mg/100 g and 1.37 mg/100 g respectively. The value of the phenolic compound for garlic was 1.37 mg/100 g which is the same value obtained by Womeni et al. [37] in Cameroon. Pebe had a value 5.36 mg/100 g which is fairly above 3.22 mg/100 g obtained by Womeni et al. [37]. This difference could be the result of the storage conditions of the spice.

Lipid contents

The highest lipid content was recorded in *pebe* with a value of 9.60%.This value is close to 8.92% obtained by Chibuzor and Assumpta [38]. This difference could be due to variation in the origin and variety of the products and it could also be partly attributed to the method fanalyses. White pepper and pepper recorded fairly higher values of 5.23% and 4.15% respectively. High lipid content is indicative of the fact that the sespicesare good sources of flavors in cetheyare rich in essential oil [19].

Protein contents

The total protein contents of raw materials were determined using Kjeldhal method. From the five ingredients used, the highest protein content value calculated was from *pebe* (24.45%), followed by pepper (19.90%), garlic (18.73%) and white pepper (15.75%) while the least value was recorded in onion (3.62). The protein content of *pebe* (24.45%)is approximately close to 27.57% obtained by Enwereuzoh [19]. This observed difference could be at tribute to the stage of maturity of the spice at the time of harvest, the variety of cultivar and partly to the method of analyses used[19].

Citation: Mezajoug Kenfack LB, Mugob Bonyesih KM Eric Serge N, et al. (2018) Valorization of Pepper (*Capsicum Chinenses Linn*) Through Formulation and Production of Ready to Use Cubes from Cameroonian Local Spices J Nutrition Health Food Sci 6(6):1-14.
DOI: 10.15226/jnhfs.2018.001147

Carbohydrate contents

The total carbohydrate contents of raw materials were calculated by difference. The highest value was recorded for white pepper with a percentage of 61.40, followed by pepper with 58.61% then *pebe* with a value of 54.29%. The least carbohydrate value was found in onion (0.96%). The carbohydrate content was 54.29% which is fairly above 44.84% reported by Chibuzor and Assumpta [38], in the same spice from Nigeria. This difference could Beas a result of the origins and varieties of the samples.

Physico chemical analysis: Colour analysis

Colour analysis carried out on the raw materials and table 6 summarizes the result. Lightness (L), trichromatic parameters L, a*, b*, Chroma (C) and Hue value (H) were calculated.

From table 6, whitepaper had the highest L*value of 99.82 followed by garlic with 97.18 the nonion with85.35. This could be due to the presence of starch which is whitish since studies carried by Pruthi [39] showed that this spice contains 52% of starch. The white pepper is most lightness ingredient amongst the 5 spices while the least lightness Oradell colour is *pebe* with an L* value of 41.99. The b*value of 56.67 for pepper was shown to be the highest followed by garlic with 37.28. These values reveal that they are both more yellowish in colour than the rest of the spices where white pepper was seen with the least value of 17.31. Mean while, *pebe* with value of 28.20 was observed to have more yellowish colour than onion. The colour variation in these spices could be due to varied quantities and types of colour pigments found in them since the spices are of different varieties, origin and families.

Table 6: Colour characteristics of the ingredients used

	Colour parameters				
Samples	**L***	**a***	**b***	**C**	**H**
Pepper	65.27±2.45	3.04±1.28	56.67±1.28	56.76±1.34	86.94±1.23
White pepper	99.82±0.01	-5.76±2.71	17.31±9.01	18.25±9.39	108.92±1.90
Garlic	97.18±4.77	-10.66±0.70	37.28±3.0	38.77±3.07	105.97±0.29
Pebe	41.99±0.72	5.41±1.22	28.20±0.85	28.73±1.04	79.18±2.14
Onion	85.35±2.31	-8.29±0.76	19.32±0.88	21.03±0.98	113.20±1.69

L = lightness. a* = redness. b* = yellowness. C = color intensity. H= Hue angle (*in degree*)*

The Hue angle value range from 0 to 360°. The Hue angles for white pepper, garlic and onion were 108.92, 105.97 and 113.20 respectively. From the Hue disc, these samples have colours ranging between lemon yellow and yellow green, implying that these spices have components that are responsible for slight green colour they possesses. *Pebe* and pepper had Hue values of 86.94 and 79.18 and from the Hue disc, these spices range between orange yellow and yellow. This can be as a result of the colour pigments contents.

Production of pepper cubes

The Simplex Lattice Design was carried out through 10 experiments to determine the appropriate quantity of the principal ingredients used for the pepper cubes formulation. Table7 presents the experimental matrix carried out along with different responses obtained for each trial. X_1, X_2 and X_3 are the proportions of pepper, white pepper and garlic respectively. Table 7 shows the results obtained considering vitamin C contents as response for 10 formulations. Formulations 1, 5 and 6 showed equal vitamin content (6.963mg/100 g), which was the highest response among all. The lower (4.940mg/100 mg) response was obtained from the third formulation.

Table 7: Experimental matrix and different responses for the mixture design

Trials	X_1 (g)	X_2 (g)	X_3 (g)	Responses
1	0.700	0.250	0.050	6.963
2	0.725	0.200	0.075	5.056
3	0.700	0.100	0.200	4.94
4	0.800	0.125	0.075	6.900
5	0.775	0.175	0.050	6.963
6	0.700	0.175	0.125	6.963
7	0.775	0.100	0.125	5.065
8	0.755	0.150	0.100	6.259
9	0.725	0.125	0.150	6.690
10	0.850	0.100	0.050	6.591

To better understand the influence of the different factors to the response, the contour plot was drawn (figure7) with Mini tabas software. This mixture contour plot represents the evolution of the surface response for the experimental domain for the 3factors (pepper, white pepper and garlic). Tegression There egression model obtained from these response is shows by the following equation: Y=6.59 A +6.96B+4.94 C +0.73 A*B-2.82A*C +4.03 B*C +33.96A*B*-18.98 A*C - 12.74 A*A*B*C Where Y is the response, A (pepper), B (white paper) and C (garlic) are the factors The statistical analysis was performed at the level of 5%. (Table 8) shows the ANOVA analysis of the vitamin C contents in the mixture design studied.

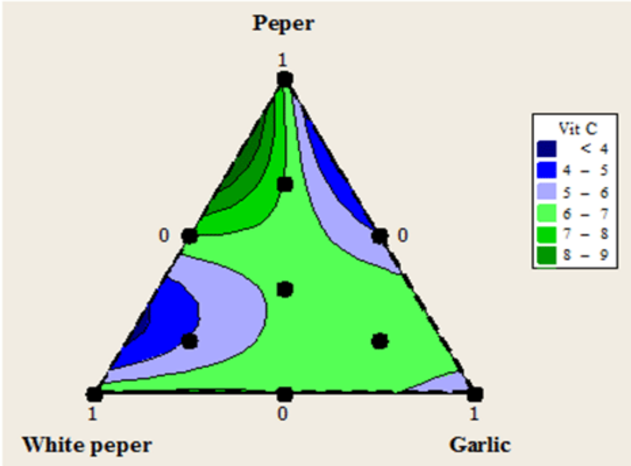

Figure 7: Mixture contour plot for Vitamin Content

Table 8: Analysis of variance for vitamin C contents

Source	DF	Seq SS	Adj SS	Adj MS	F-value	P-value
Regression	8	6.79977	6.79977	0.84997	201.78	0.054
Linear	2	1.75328	2.3189	1.15945	275.25	0.043
Quadratic	3	0.79339	1.21296	0.40432	95.98	0.075
A*B	1	0.00097	0.02214	0.02214	5.26	0.262
A*C	1	0.22221	0.33248	0.33248	78.93	0.071
B*C	1	0.5702	0.67886	0.67886	161.16	0.050
Full Cubic	2	4.23558	4.13162	2.06581	490.41	0.032
A*B*(-)	1	2.76808	3.94175	3.94175	935.75	0.021
A*C*(-)	1	1.4675	1.23059	1.23059	292.14	0.037
Special Quartic	1	0.01753	0.01753	0.01753	4.16	0.290
A*A*B*C	1	0.01753	0.01753	0.01753	4.16	0.290
Residual Error	9	0.00421	0.00421	0.00421		
Total		6.80398				

DF: Degrees of Freedom and MS: Mean Square; SS: Sum of Squares; Adj-R^2 = 99.44%.
R^2=99.94%.

The linear and the full cubic terms with p-values lower than 0.05; significantly influence the vitamin C content of the product. In order to produce the pepper cube with higher quantity of vitamin C, the studied factors were optimized. Thus, the formula obtained for maximum amount of vitamin C content as pseudo components was A=0.778, B=0.222, C=0. The equivalent corresponding proportions (in%) for these components were 0.817,0.133 and 0.05% respectively for A, B and C. The implementation of this optimal proportions gave 10.578± 0.619mg as vitamin content which was very close to the predicted value(10.056mg).This result along with the higher value of the determination coefficient (R2=99.94%) testified that the proposed model explaining the phenomenon is acceptable and therefore can be used to predict the vitamin C content of the final product. In fact, to be acceptable, the coefficient of determination (R2) should be higher than 80% [40].

Sensory evaluation and acceptability

The mean scores of the varied responses obtained from the hedonic acceptance and descriptive sensory tests of the five peppers on cubes am pleaser summarized on figures 8 and 9 Sample107 had an overall preference over the other four followed by sample 218. This can be explained by the fact thatsample107 had the least pungencas are sult of the smaller quantity of onion used. In fact onion has been reported by Pruthi [39] to be pungent as are sult of the interaction between S-substituted-L-cysteine sulfoxide derivative sand allinase enzymes. Hence 7.5g of onion used in sample218 contributed to the increment of the products pungency.

From figure 8, it was noticed that all of the samples fell within the acceptability zone with average means cores between 6and7. In order to select the best formulation among the five samples, samples107and 218 scores were drawn individually. Figure9 shows the hedonic acceptance and descriptive sensory of the samples 107 and 218.

From figure 9, it is clear that with the combination of the studied parameters, sample 107was more preferred than sample218. In fact, it recorded 6.83 asscoreona scale of 9 compare to sample 218, which score was6.47/9.Both samples were retained for further analyses.

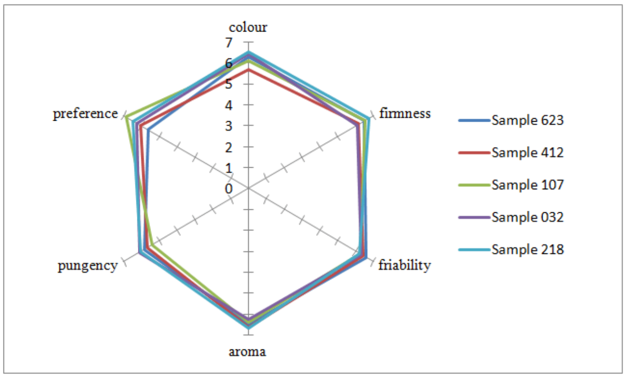

Figure 8: Hedonic acceptance and descriptive sensory of the pepper cube samples

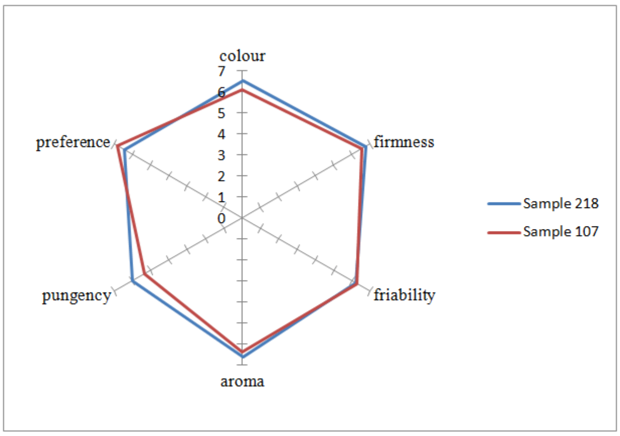

Figure 9: Hedonic acceptance and descriptive sensory of the samples 107 and 218

Analyses of the retained samples

Chemical analyses of the retained samples

The two final retained samples were analyzed biochemically and results are represented in table9. As shown in table9, the lipid content for sample107 was10.58% while the one of sample218 was 9.14%. The protein content for sample107 (49.51%) was also slightly higher than that of sample 218 (47.24%). This difference can be due to the varied quantity of *pebe* used in their formulation. Sample 218 had 1g of *pebe* while sample107 possessed 1.75g and it is the spice that was shown to contain the highest lipid content among the 5 ingredients. The carbohydrate contents of both samples were very low 0.28 and 2.38% respectively for sample 107and sample218. Ash content for sample107 (2.60%) was less than that of sample218 (2.86%) and this could be because of the solubility of some minerals in the available moisture provided by the onion. Also, it could be as a result of the origins of the product's components since the chemical composition of plants are controlled by climate, soil and plant factors and same plant species might show different responses to uptake of nutrients from the soil [41]. From these analyses, sample 107 was shown to have a higher vitamin C content of 127.46 mg vitamin C/100 g of dry weight compared to sample 218 which had 110.44 mg vitamin C/100 g of dry weight. It was also shown to contain a higher level of phenolic compounds (69.28 mg/100 g) than sample 218 with a total phenolic content of 66.35 mg/100 g. This could be as a result of interactions between the phenolic compounds and other constituents found in the other spices since phenolic compounds belong to different classes which react differently [42]. The sample 107 can therefore be suggested to contain a higher antioxidant property than sample 218 since vitamin C and phenolic compounds both have antoxidative potentials [43].

Table 9: Physico-chemical properties of the retained samples (% of dry weight)

Parameters	Samples	
	Sample 107	**Sample 218**
Moisture content (%)	37.52 ± 0.13	43.36 ± 0.40
Ash content (%)	2.60±0.00	2.86±0.12
Protein N x 6.25 (%)	49.51 ± 0.08	47.24 ± 0.13
Lipid (%)	10.58± 0.02	9.14 ± 0.08
Carbohydrate (%)	0.28	2.38
Vitamin C (mg)	127.46 ± 2.14	110.44 ± 2.03
Phenolic compounds (mg)	69.28 ± 0.04	66.35 ± 0.46
L*	47.48±5.01	35.40±1.34
a*	0.94±0.80	1.03±0.43
b*	28.27±3.67	24.39±0.37
C	28.29±3.68	24.42±0.39
H	88.19±1.58	87.60±0.97

L = lightness. a* = redness. b* = yellowness. C = color intensity. H= Hue angle* (in degree)

Colour analyses

The L*, a*, and b*, Chroma and Hue angle characteristics of the retained samples after sensory evaluation are summarized in table5. The L*value (lightness) for sample107was shown to be 47.48; higher than that of sample218 (35.40). Both samples had values below 50 implying that they had dark colours with that of sample218 having a much darker colour. The redness(a*value) were 0.94 and 1.03 respectively for samples 107 and 218, indicating that both samples have more of the greenish colour than the red which could be due to the presence of the components from garlic and onions in cethey show edhigher negative values(greenness) of -10.66and-8.29 respectively. From the*values, Sample 218showeda more greenish colour than sample107.The yellowness of the food products as specified by b*for both samples (107and218) were 28.27 and 24.39 respectively. The Chroma(C) or colour strength refers to the amount of visual difference from a grey of the same value. It is the intensity and the saturation level of a particular hue (closest “pure “colour).The Chroma values for samples 107 and218 were 28.29 and 24.42 respectively. This indicates that the colour intensity of sample 107 was much closer to the saturation of level of pure pepper (56.76) than sample 218. This difference in the saturation level between samples107, 218 and pure pepper can be as a result of the low Chrome values of onion(21.03),white pepper(18.25)and *pebe* (28.73).The Hue angle is the attribute of colour by which it is perceived to be red, yellow ,green, blue, purple, etc and generally ranges from 0 to 360°. The Hue angles of samples 107 and 218 were 88.19 and 87.60respectively which fall within the desired range. From the Hue disc, these two samples eventually have colours found between orange yellow to yellow which is due to pepper the main component in the products.

DPPH radical-scavenging activity

DPPH free radicals cavenging method was used to evaluate the antioxidant activities of there obtained formulations. Figure10 shows that, both of the retained samples can scavenged the free radical at different proportions. In order to compare the free DPPH radicals cavenging activity of retained samples (107and218), with the one provided by as corbic acid used as reference, the IC50 was calculated (figure11). IC50 is the concentration of sample (mg/ml) required to scavenge 50% of DPPH. It was determined from figure10 which shows the percentage of DPPH inhibition activity vers us the different concentrations of samples.

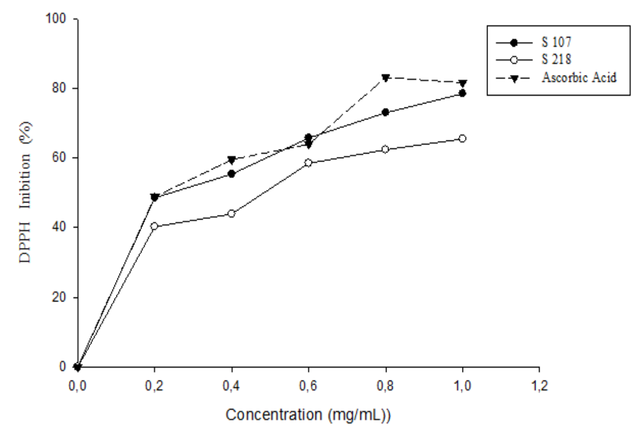

Figure 10: DPPH radical scavenging activity of the retained samples in comparison with ascorbic acid as standard

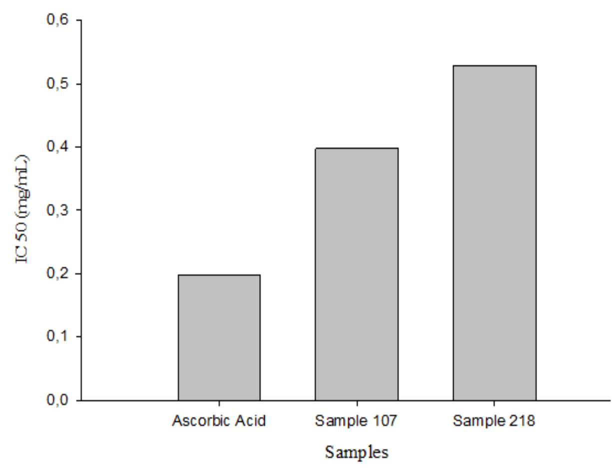

Figure 11: IC_{50} values of the retained samples and ascorbic acid

The DPPH scavenging effect for sample 218 was lower than that of sample107.This can be due to the fact that, the vitamin C and phenolic content values in the sample were lower (110.44 mg vitamin C/100g dry weight and 66.35 mg/100g dry weight) for vitamin C and phenolic compounds respectively. Both samples showed lower IC50 values compared to ascorbic acid. However, sample107exhibited about 50% of DPPHs cavenging activity compared to ascorbic acid. With this, sample107can be used for scavenging of free radical in our body more than sample208. In fact in 2012, Everette and Islam [44] reported that vitamin C interact with and stabilize free radicals within the body.

Base on all the above analyses, the best proportions for pepper cube making was defined as 50%of pepper enrichment, 32.5%of onion and 17.5% of *pebe.*

Conclusion

This work was carried out with the aim of formulated of pepper cube by adding white pepper, garlic, onion and pebe. Pepper cube formulated with the selocal ingredients found in Cameroon will promote the revalorization. The sensory acceptance of this product implies that, it present characteristics desired by consumers. This acceptance will enable its economic effect and allow users to gain time in labour. From this study, it is evident that it could be a means of contributing towards the economic and industrial growth by promoting technological innovations through research.

References

1. Ludovic A, L Philippe. Peri-urban Agriculture: The Case of Market Gardening in Niamey, Niger. Journal compilation, African Centre for Economics and Finance, 2011;3(1):68-79.
2. Djeukeu AW, Marie Modestine Kana Sop, Marlyne-Josephine Mananga, Nicolas Polycarpe Nolla, Inocent Gouado, Tetanye Ekoe. Feeding Practices and Nutritional Parameters of Children Aged 6-14 Years from Cameroon. Global Journal of Medical research Interdsciplinary. 2013;13(2):2249-4618.
3. Vijaya BR, P Sasikala. Capsaicin and Colour Extraction From Different Verities of Green and Red Chilli Peppers of Andhra Pradesh. International Journal of Advanced Scientific and Technical Research. 2013;2:133-140.
4. FAOSTAT, Statistical Database. Food Supply, Crops Primary Equivalent. 2011.
5. Estrada B, María A. Bernal, José Díaz, Federico Pomar, Fuencisla Merino et al. Capsaicinoids in vegetative organs of Capsicum annuum L. in relation to fruiting. Journal of Agricultural and Food Chemistry. 2002;50(5):1188–1191. doi: 10.1021/jf011270j
6. Nielsen S. Food analysis, laboratory manual 3ed. 2003, London: kluwer academic premium Publishers. 1.
7. Jean-Marie A, S Gilbert. Formulation Présentation générale, In: technique d'ingenieur, in Technique d'ingenieur, Dunod, Editor. 2006: Paris, France. 2110-1 –2110-20.
8. Paksoy M, ÖS Uslu. The marketing and problems of red pepper in Turkey. in VI. Symposium of Vegetable Cultivation. 2006. Kahramanmaraş-Turkey.
9. Kidmose U, R.-Y.Yang, S.H.Thilsted, L.P.Christensen, K. Brandt. Content of carotenoids in commonly Asian vegetables and stability and extractability during frying. J Food Comp Anal. 2006;19(6-7):562–571.
10. Packer L. Possible factors influencing aging. in United Nations and World Health Organization First Joint Conference on Healthy Aging. 1996. New York.
11. Tchiégang, C, MB Ngassoum. Conservation de trois variétes de piment (Capsicum sp.) par préparation traditionelle d'extraits huileux. Agronomie Africaine. 1999:11(1):19-27.
12. Tchiégang C, FP Moundipa, NV Kapchie. Etude compare de quelques constituants chimiques de deux types de piment (Capsicum annum L.) pendant la conservation dans une saumure acide. Journal of Food Engineering. 1999;42(2):117-123.
13. Naima Z, et al. Assessment of Color, Capsaicinoids, Carotenoids and Fatty Acids Composition of Paprika Produced from Moroccan Pepper Cultivars (Capsicum annuum L.). Journal of Natural Sciences Research. 2013;3(7):111-118.
14. Linda, J, M Harris. Peppers: Safe methods to store, preserve and enjoy. Publication 8004. 1998.
15. Berke T, M Shieh. The Asian vegetable Research development centre. Pepper project, in In the proceeding of the 16th International pepper conference Tampico. 2002;Tamaulipas:Mexico,02-10.
16. Yaméogo CK, et al. Food practices in Ouagadougou, in Cereals, legumes, tubers and vegetables. 2002;CNRST/CIRAD: Burkina Faso. 111-132.
17. Goupy J, L Creighton. Introduction aux plans d'expériences. ed. 3. 2006, Paris: Dunod.
18. Vaclavik VA, Elizabeth W. Christian. Essential of food science. ISBN, Editor. 2008:New York.
19. Enwereuzoh RO, et al. Flavour Extraction from Monodora Myristica and Tetrapleura Tetraptera and Production of Flavoured Popcorn from The Extract. European Journal of Food Science and Technology. 2015;3(2):1-17.
20. AFNOR. Collection of French standards for fruit and vegetable derived products, in Jus de fruits. 1982: Paris Defense (France).
21. AOAC. Official Methods of Analysis. in Association of Official Analytical Chemists. 2002. Gaithersburg, USA.
22. AACC. Approved Methods of American Association of Cereal Chemists, in American Association for Cereal Chemistry. 1999, Paul: USA.
23. Bourely J. Observation sur le dosage de l'huile des graines de cotonnier. Coton et Fibres Tropicales. 1982;37(2):183-196.
24. FAO, Food and A gricultural Organization of the United Nations, Rome Declaration on World Food Security, in Proceedings of World Food Summit. 2008: Rome, Italy. 13–17.
25. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists. in Association of Official Analytical Chemists. 1990. Arlington.
26. Marigo G. Méthode de fractionnement et d'estimation des composés phénoliques chez les végétaux, Analysis. 1973;2(2):106-110.
27. Zhang D, Y Hamauzu. Phenolics, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking. Food Chemistry. 2004;88(4):503-509.
28. Ismail Y, et al. Effects of different thawing methods on the quality of meagre fillets. 2015;62.
29. Singh-Ackbarali D and R Maharaj. Sensory Evaluation as a Tool in Determining Acceptability of Innovative Products Developed by Undergraduate Students in Food Science and Technology at The University of Trinidad and Tobago. Journal of Curriculum and Teaching. 2014;3(1):10-27.
30. Aka-Boigny AA, et al. Nutritional and Sensory Analysis of Milk Processed from Seeds of Sweet Pea (Cyperus esculentus L.) Consumed in Côte d'Ivoire. Journal of Applied Life Sciences International. 2016;8(2):1-12.
31. Segnou J, et al. Effect of Chemical Treatments on Pests and Diseases of Pepper (Capsicum annuum L.). Greener Journal of Agricultural Sciences. 2013;3(1): 012-020.
32. Ozgur M, et al. Functional compounds and antioxidant properties of dried green and red peppers. Afr J Agric Res. 2011;6(25):5638–5644.
33. Howard LR, et al. Provitamin A and ascorbic acid content of fresh pepper cultivars (Capsicum annuum) and processed jalapenos. J Food Sci. 1994;59(2):362-365.

Citation: Mezajoug Kenfack LB, Mugob Bonyesih KM Eric Serge N, et al. (2018) Valorization of Pepper (*Capsicum Chinenses Linn*) Through Formulation and Production of Ready to Use Cubes from Cameroonian Local Spices J Nutrition Health Food Sci 6(6):1-14. DOI: 10.15226/jnhfs.2018.001147

34. Kim S, Ki Won Lee, Jaebok Park, Hyong J Lee, In K Hwang, et, al. Effect of drying in antioxidant activity and changes of ascorbic acid and colour by different drying and storage in Korean red pepper (Capsicum annuum L.). Int J Food Sci Technol. 2006;41(s1):90–95.
35. Vega-Gálvez A, R Lemus-Mondaca, C Bilbao-Sáinz, P Fito, A Andrés, et, al. Effect of air drying temperature on the quality of rehydrated dried red bell pepper (var. Lamuyo). J Food Engineering. 2008;85:42–50.
36. Campos, Karen Ramírez Gómez, Yolanda Moguel Ordoñez, David Betancur Ancona et, al. Polyphenols, Ascorbic Acid and Carotenoids Contents and Antioxidant Properties of Habanero Pepper (Capsicum chinense) Fruit. Food and Nutrition Sciences. 2013;4:47-54.
37. Y S Velioglu, G Mazza, L Gao, BD Oomah. Antioxidant Activity and Total Phenolics in Selected Fruits, Vegetables, and Grain Products. J Agric Food Chem. 1998;46(10): 4113- 4117.
38. Chibuzor O, O Assumpta. Nutritional Evaluation of Some Selected Spices Commonly Used in the South-Eastern Part of Nigeria. Journal of Biology, Agriculture and Healthcare. 2014;4(15):2224-3208.
39. Pruthi JS. Spices and condiments: Chemistry, Microbiology, Technology. Adv Food Res Suppl. 1980; 4:1-449
40. Joglekar AM, AT May. Product excellence through design of experiment. Cereal Foods World. 1987;32:857-868.
41. Koyuncu F, M Çetinbaş, E Ibrahim. Nutritional constituents of wild grown black mulberry (Morus nigra L.). Journal of Applied Botany and Food Quality. 2014;87(1):93-96.
42. Abdou BA, et al. Phenolic compounds and radical scavenging potential of twenty Cameroonian spices. Agric Biol J N Am. 2010;1(3):213-224.
43. Maksimova V, et al. Antioxidative effect of Capsicum oleoresins compared with pure capsaicin. Journal of Pharmacy. 2014;4(11):44-48.
44. Everette JD, S. Islam. Effect of extraction procedures, genotypes and screening methods to measure the antioxidant potential and phenolic content of orange-fleshed sweet potatoes (Ipomoea batatas L.). Am J Food Technol. 2012;7(2): 50-61.