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Development and Sensory Evaluation of a Cookie from Composite Sorghum and Cowpea Flour

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Abstract

There are many opportunities in the global food market for innovations, through the valorization of artisanal technologies based on the local raw material. In this context we were interested in the development of cookies based on a local variety of sorghum from northern Cameroon, the so-called S35 sorghum variety and a local cowpea from northern Cameroon the so called "sekem variety". During the production of flours for cookies, the extraction yields were as follows: 46.67% for sorghum flour and 55.60% for cowpea flour. It was found that it was technically possible to produce these types of cookies. Several production trials were done and submitted to a panel for sensory analysis. The results showed that amongst different produced cookies, the one with 45% sorghum, 40% wheat, and 15% cowpea was the most appreciated by the members of the test panel. 70% of panelists considered them as "very good" against 30% who considered them as "good". 60% of test panelists indicate that cookies with 50% sorghum, 40% wheat and 10% cowpea were "good", against 40% who thought they were "not too bad". Meanwhile 50% of the test panelists considered that the cookies made of 55% sorghum, 40% wheat and 5% cowpea were "good" against 50% who indicate this as "bad" and not too bad". Proximate analysis of the cookies of trial 3 showed that it contained about 12.50% proteins, 84.10% carbohydrates, 27.34% lipids and 1.50% fiber.

Keywords: Cookies; Sorghum; Cowpea; Northern Cameroon; Sensory evaluation

1 Introduction

Cowpea and sorghum are among main food crops in the northern region of Cameroon (Boukar et al., 2019; Guei et al., 2011; Ingenbleek et al., 2019; Ishikawa et al., 2020). These species are the main staple food for people living in this part of the country (Silue et al., 2011; Sterns & Bernsten, 1994). The use of cowpea and sorghum for human food is very diverse in the area (Ngambeki et al., 1990). They are used as porridge, cake, bread, soft drinsk as well as form of alcoholic beverage (Carine et al., 2019; Singh, 2020; Visarada & Aruna, 2019). The Sudan-sahelian zone is generally known as a chronic food insecurity area. This is because of several internal factors that are linked to demography, climatic and soil conditions, farmers, agricultural inputs, post-harvest conservation technology, socio-cultural practices, famine and the invasion of local markets by imported products (Burfisher, 1984; Ngongang, 2019). Add to these natural events we have had in the past five years civil insurgents, such as the Boko haram (Abeh, 2003; Fungo et al., 2016). Increased pressures on food supply is also due to the massive move-

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ment of people across the border with Nigeria and Chad (Kah, 2017). For this reason, we proposed to develop a new product based on cowpea flour and sorghum for peoples suffering from malnutrition, some immune deficiencies; in the humanitarian field, to reduce food insecurity and instability, and finally in order to promote our local products. The objective of this study is to diversify the industrial use of sorghum and cowpea in order to boost the use of these two locally produced speculations. More specifically, it will focus first in the production of sorghum and cowpea flours which will be used to make cookies; to identify problems related to the cookie processing based on sensory tests and then propose corrective actions to improve cookie manufacturing process.

2 Material and Methods

2.1 Material

The plant material used for this work consisted of cowpea grains as well as sorghum grains all supplied respectively by the cowpea section and the sorghum section of Institute of Agricultural Research for Development, Maroua research station in the far north of Cameroon. The plant material also consisted of wheat flour, ingredients such as: margarine, salt, water, baking powder, sugar, all bought in food at the central market of Maroua. The sorghum flour used for this work came from an improved variety of sorghum commonly known as S35. S35 is a sorghum variety of ivory yellow color, with a fairly short development cycle and whose characteristics in terms of health and nutrition are more important compared to local varieties (Kamuanga & Fobasso, 1994; Ndjomaha et al., 1998). The cowpea flour, was developed from a local variety, the so called "sekem variety" cowpea (Gonné et al., 2013).

2.2 Methods

Sorghum flour production

The S35 sorghum variety, was winnowed, sorted, washed and dried then crushed and sieved with a coarse mesh sieve (Fig 1). The coarse grains were again crushed and sieved with this time a fine mesh sieve. The fine flour was kept in dry conditions while the grits was mixed again with unground grain to be crushed once more.

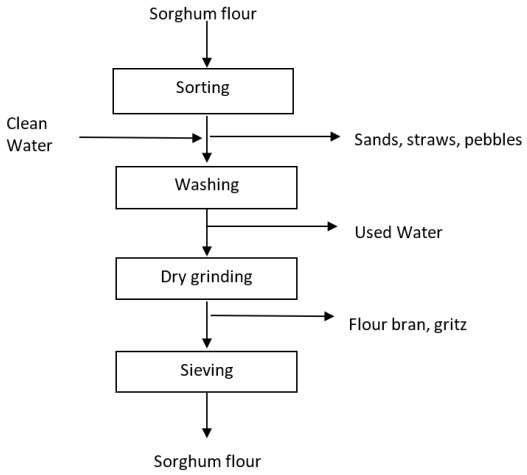

Figure 1: Sorghum flour processing

Cowpea flour production

Cowpea was sorted, washed, soaked, stripped of its film, and then dried. The clean dry grain was then crushed and sieved using a fine mesh sieve and the grits was again crushed to obtain as much flour as possible (Fig 2).

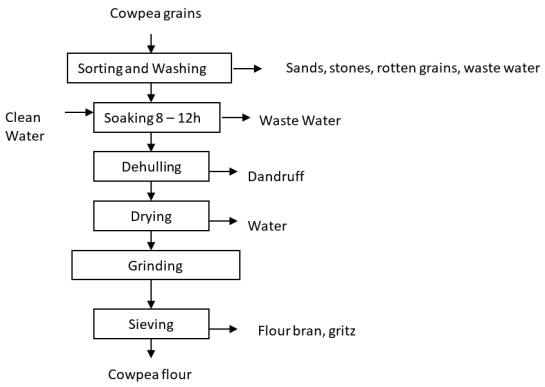

Figure 2: Process production of cowpea flour

Processing of cookies

The classic processing method of cookies was used and consisted at weighting and mixing flour and ingredients, until a homogeneous paste was obtained and then allowed to let stand for about 15 minutes. Then the dough was cut according to the desired shape then finally baked in an oven at 150 ^{o}C for 1.5h. Three formulas of cookies with known different levels of ingredients were tested; there were not a specific experimental design for mixtures but the majors ingredients (Sorghum, wheat and cowpeas) were mixed to proportions with a step of 5 decrease or increase accordingly. Several cookies with fixed levels of ingredients were made as follows: Formula 1 was composed of 45% sorghum, 40% wheat, and 15% cowpea; formula 2 was composed of 50% sorghum, 40% wheat and 10% cowpea, the formula 3 was 55% sorghum, 40% wheat and 5% cowpea.

Sensory evaluation

"Sorghum/Cowpea", cookies and commercial bran cookie purchased from local market, were presented to a panel of experienced panelists who were regular cookies users and university students. The university students were regular cookies consumers but not experienced testers. The sensory analysis procedure suggested by Rivella (1987) was used. The tasting panel consists of 65 people of different genders with ages ranging from 25 to 50 with an average age of 30. They were selected based on the fact that they're generally practicing activities that require enough energy and especially physical effort, hence there's a need to consume items rich enough in energy in order to be able to compensate losses of energy. The ranking of different cookie formulas based on these flours varies according to the quality of the products obtained. Each panelist was given an evaluation form for each of the cookie samples. The form included five sensory attributes: overall appearance, texture, taste, aroma, color, and overall acceptability (harmony). Panelists were asked to assess the samples in terms of the listed attributes using a nine-point hedonic scale with 9 representing like extremely and 1 indicating dislike extremely. The tasting was carried out in a highly illuminated tasting room. Panelists were provided with water to rinse their mouth after each round of tasting and were prevented from communicating with each other to avoid undue biases. Each panelist was served with 10 g of each "cookie" sample and commercial cookie in different coded form. All experiment was done in triplicate for each of the in four sessions.

3 Physicochemical analysis

3.1 Flour extraction rates

The determination of the yield of sorghum and cowpea flours was carried out by a conventional method, which is based on the measurement of the difference in mass of the samples of raw materials before and after dry milling. To do that, a small quantity of grain sorghum or cowpea were collected after they were removed from the bags. Then sorted until clean seeds are obtained. The clean sets of grains were weight (S1 for sorghum and C1 for cowpea). The samples were milled after tempering and drying in a Buhler mill to obtain bran and flour yields. The obtained grits were again weight (S2 for sorghum and C2 for cowpea). The flour yield calculation is given by the following relationship (Bhatty, 1997):

$$\text{Sorghum Yield Rate (RS)} = \frac{(S_1 - S_2)}{S_1} \times 100 \quad (1)$$

With respectively:
S_1 - sorghum mass before grinding;
S_2 - grits mass after grinding.

$$\text{Cowpea Yield Rate (RC)} = \frac{(C_1 - C_2)}{C_1} \times 100 \quad (2)$$

With respectively:
C_1 - Cowpea mass before grinding;
C_2 - Cowpea mass after grinding.
All results were the average of three determinations and are expressed as a percentage (%).

3.2 Determining the nutritional composition of cookies

The determination of nutritional composition of cookies was carried out as described by Bognár (2002). It is based on the addition of the

different nutritional compound content of each ingredient used to produce cookies.

Protein The protein content is given by the relationship: $P = \frac{P_i}{M} \times 100$, with P - protein content in the cookie, it expresses itself as a percentage (%);P_i - protein content of all ingredients and M = Mass of the cookies.

Carbohydrate Carbohydrate content is expressed by the following relationship: $G = \frac{G_i}{M} \times 100$, with: G - carbohydrate content in the cookie, it expresses as a percentage (%) G_i - carbohydrate content of all ingredients and M = Mass of the cookies.

Lipids The lipid content is given by the relationship: $L = \frac{L_i}{M} \times 100$, with L - lipid content in the cookie, it expresses percentage (%), L_i - fat content of different ingredients and M = Mass of the cookies.

Fibre The fiber content is given by the relationship: $F = \frac{F_i}{M} \times 100$, with: F - fibre content in the cookie, it expresses itself as a percentage (%), F_i - fibre content in each ingredient and M = Mass of the cookies.

Energy The energy value of the cookie is given by the following relationship: $E = \frac{E_i}{M} \times 100$, with E - the energy value of the cookie, it expresses itself in kilocalorie (Kcal), E_i - energy value of different ingredients and M = Mass of the cookies.

Statistical Analysis Data was subjected to analysis of variance and means were separated using Duncan's multiple range test at P<0.05 (Steel et al., 1980).

4 Results and discussion

4.1 Production of sorghum flour

750g of sorghum of the improved variety S35 was weighed for processing into flour as shown in Figure 1. According to this figure, sorghum was not peeled before being ground as indicated in the literature. This is in order to obtain a whole meal flour, that is to say to be quite rich in nutrients such as fiber, carbohydrates and especially proteins, vitamins and mineral (Desikachar, 1981), the quantities of which decrease significantly during the shelling operation. In fact, slightly different milling processes were used for the various grains, but the process can generally be described as grinding, sifting, separation and regrinding. The final nutrient content of a cereal after milling will depend on the extent to which the outer bran and aleurone layers are removed, as this is where the fiber, vitamins and minerals tend to be concentrated (McKevith, 2004). As the objective of this is the maximum possible preservation of nutrients hence the interest of eliminating the shelling operation while processing the S35 into flour.

4.2 Production of cowpea flour

500g cowpea grains were weighed for this flour and proceed as describe in fig 2. However, unlike the fact that it is generally say to avoid soaking during production of this flour (Coffigniez et al., 2019) we have given preference to the method of production of cowpea flour with an improvement in the soaking operation (Fig 2). Soaking time has been increased, meaning that cowpea grains were soaked from 8 to 12 hours. This was done to allow swelling of the grains, improvement of digestibility and, above all, to eliminates indigestible sugars (Ibrahim et al., 2002; Idun-Acquah et al., 2019).

4.3 Flour extraction yields

Analysis of sorghum flour extraction yields indicate a rate of 46.67%. The resulting yield is explained by the abrasive milling method used for flour production. The abrasive milling extraction method is said to causes more losses (Kebakile et al., 2007). Because during this transformation, the physical force exerted by the grinder is less intense compared to that of a mechanical roller grinder (Birania et al., 2020). Therefore, it is important to use a more suitable grinder for a better flour yield. The yield obtained, i.e. 46.67%, is also explained by the fact that the amount of crushed flour does not completely pass through the mesh of the sieves used as set by the CODEX-

STAN 173-1989 World Standard (1989). This is due to the coarse granularity of the flour via a not efficient enough grinding that can make the flour thinner.

4.4 Analysis of cowpea flour yields

Analysis of cowpea flour extraction yields was found to be 55.60% meaning that from 500 g of cowpea grains weighed before sorting, soaking, drying and washing, we get 222 g of waste, and 278 g of cowpea fine flour. As previously notice for sorghum flour, this yield is explained by the abrasive milling method used for cowpea flour production used (Ningsanond & Ooraikul, 1989). This method is said also to causes more losses. During this operation, when the cowpea grains are ground, the physical force exerted by this type of grinder is not intense. Therefore, it is important to use a more suitable grinder for a better cowpea flour yield. The yield obtained, i.e. the 55.60% cowpea flour, is also explained by the fact that the amount of crushed flour does not completely pass through the mesh of the sieves used as set by the CODEX-STAN 173-1989 World Standard (1989). This is due to the coarse granularity of the flour via a not efficient enough grinding that can make the flour thinner.

4.5 Processing of sorghum and cowpea flours into cookies

The amount of mix sorghum/cowpea flour was 500 g at the laboratory level and each test was repeated three times. The percentages of each flours and other ingredients vary in order to get the right formula for making a cookie that consumers can found appreciable, whether in terms of texture, taste, smell and even color (Fig 3). No food additives or preservatives neither aromas, have been added as shown in Figure 4. This is because we wanted to produce a cookie purely based on natural products. Wheat flour was added to the preparation method of these cookies in order to make the dough bind as wheat flour contains gluten. Three formulas of cookies were used as follows:

The composite flours used for cookies varies as follow:

Formula 1 40% Wheat flour, 55% S35 sorghum flour, 5% cowpea flour

Formula 2 40% Wheat flour, 50% S35 sorghum flour, 10% cowpea flour

Formula 3 40% Wheat flour, 45% S35 sorghum flour and 15% cowpea flour.

Figure 3: Appearance of the cookies from the three trials (from right to left, trials 1, 2, 3)

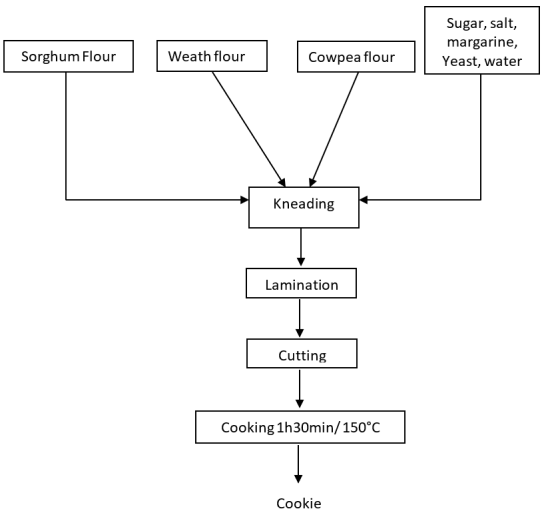

Figure 4: Process production of cookies

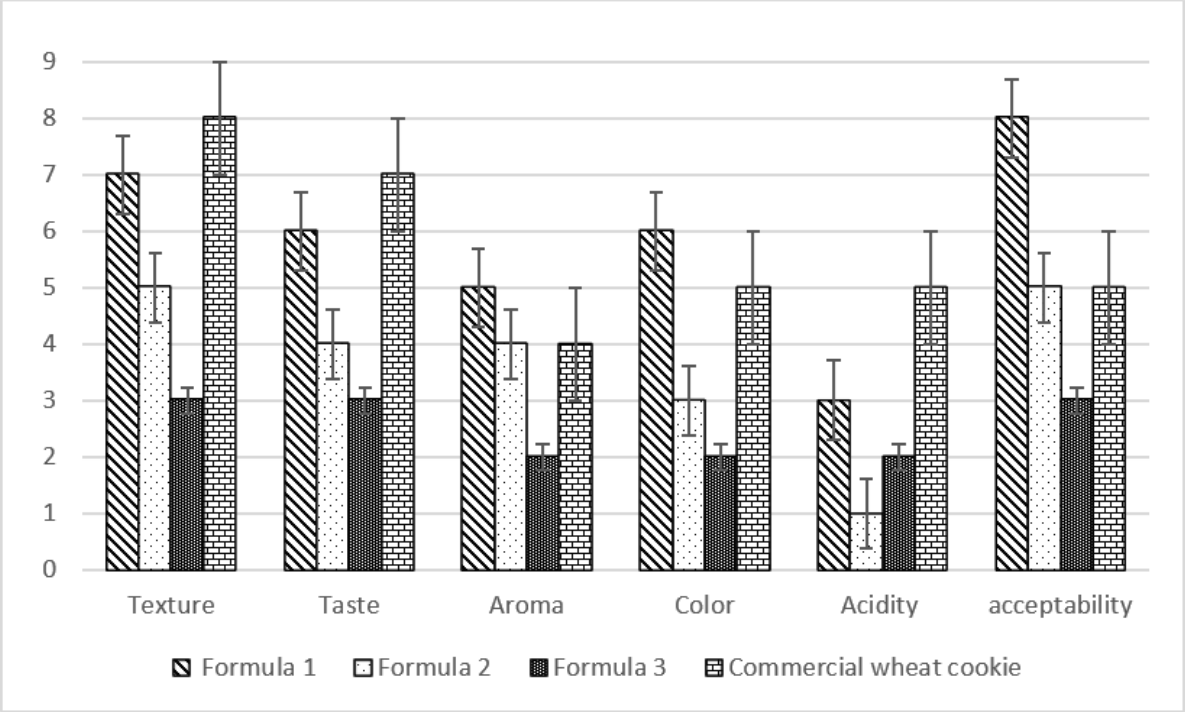

Figure 5: Sensorial attributes of different formulas of sorghum/cowpeas cookies

Table 1: Proximate composition of Sorghum/cowpeas cookies

	Formula 1	**Formula 2**	**Formula 3**
Proteins (g)	62.9 ± 21.2^{a}	90.75 ± 11.8^{b}	152 ± 31.6^{c}
Sugar (g)	420.7 ± 48.1^{a}	210.7 ± 21.0^{b}	130.6 ± 21.0^{c}
Lipids (g)	136.7 ± 16.8^{a}	167.55 ± 31.3^{bc}	190.41 ± 12.1^{d}
Fibers (g)	7.5 ± 2.1^{a}	4.1 ± 1.1^{ba}	2.5 ± 0.1^{c}
Energy (kcal)	1711.7 ± 13.8^{a}	1206.7 ± 10.8^{bc}	812.4 ± 12.8^{c}

In the same line, values with the same superscript letter are not significantly different ($p>0.05$)

4.6 Sensorial attributes of the cookies

According to the panelists, sorghum and cowpea cookies are acceptable as cookies and they found that the composite flour cookies differ slightly more from cookies made from 100% wheat flour (P<1). The only differences were found at the levels of texture and color (fig 5). The mixed flour cookies is harder than 100% wheat cookies. This may be due to the absence of some ingredients such as milk and eggs in cookies (Gani et al., 2015) and especially by the fact that the granularity of sorghum flour and cowpea flour is denser than the one of wheat flour (Barak et al., 2014). In terms of color, cookies made from mixed flours are darker than the one done with 100% wheat flour. Cookies obtained are of acceptable quality. 70% of the panelists say mixed sorghum/cowpea flour cookies are acceptable and only 30% dislike. Formula 1 cookie was more appreciated considering color factor only, than the other formula including 100% wheat cookie. Regarding the aroma, the panelists find that the sorghum is much more striking than the other ingredients in these cookies, this may be due to the higher amount of sorghum flour during preparation. However, cookie from formula 1 was more appreciated than remaining formulas including wheat cookies.

As for texture, the cookies for formula 1 are harder than the two other mixed flours formulas samples, according to panelists. This is can explained by the fact that there is enough sorghum flour whose grain size are denser than other flours which are finer (Ferreira et al., 2016).

Regarding the taste, the panelists found that the mixed flours formula tastes like rancid flour lacking in sugar. This is explained by the fact that it has not been dried in the oven sufficiently that is to say that the cooking time was insufficient. Regarding sugar, it was introduced during production in very small quantities. For Harmony, the formula 1 score was better than the other. The harmony is in relation with all other criteria, in particular the texture odor and taste that is to say that, according to the panelists, cookies from mixed flour have a better characteristics compared to other formulas.

4.7 Nutritional attributes of cookies

From table 1, it can be notice that sorghum /cowpea cookies have a high energy value as well as protein. As amount of cowpea increase in the formula as the amount au protein increase in the final cookies. The protein content of formula 3 cookies seems better and can be explained by the fact that several ingredients with high nutrient content were added, in particular cowpea which is a good source of protein and energy (Giami, 1993; Vasconcelos et al., 2010). This can be interesting for infants as well as individuals who suffer malnutrition (Iqbal et al., 2006).

Concerning the fiber content of cookies, we can notice that it decreases or increases according to the amount of sorghum added or reduce (Table 1). The interesting amount of fiber can thus be link to sorghum flour, which during its processing into flour has not undergone the de-hulling stage in order to reduce as much as possible these fibers.

5 Conclusion

This work aims at valorizing local innovations, through the characterization of artisanal technologies based on the local raw material. In this context, we developed cookies based on a local variety of sorghum and a local cowpea variety. The process production was designed, and three formulas were tested. It was found that it was technically possible to produce these types of cookies and several productions trials were done and submitted to a panel for sensory analysis. The extraction yields of sorghum flour and cowpea flour were determined. Results showed that amongst the different cookies produced, the one composed of 45% sorghum, 40% wheat, and 15% cowpea was the most appreciated by the members of the test panel. Proximate analysis of the cookies of trial 3 showed that it contained about 12.5% proteins, 84.10% carbohydrates, 27.34% lipids and 1.50% fibers.

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