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RESEARCH ARTICLE

CHARACTERIZATION AND DEVELOPMENT OF DIETETIC BISCUITS AT BASE OF THE COMPOSITE FLOURS OF TARO (*COLOCASIA ESCULENTA*/ CORN IN SUBSTITUENT SUGAR BY STÉVIA (*RÉBAUDIANA BERTONI*)

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ABSTRACT

The objectives of this work were firstly to produce the flour containing taro (*Colocasia esculenta* , secondly to formulate and characterize the composite flours taro/corn and thirdly to work out and characterize dietetic biscuits at base flours composite of taro *(Colocasia esculenta* / corn and in substituent sugar by Stévia (*rébaudiana Bertoni)* The proportions of flours selected were following: flour of the type A (0 % taro -100 % corn), flour of the type B (15% taro - 85 % corn), of the flour of the type C (30 % taro - 70 % corn) and flour of the type D (45 % taro - 55 % corn). The results show that the moisture contents, of proteins and lipids of the flours of the composite flours containing taro/corn of type A, B, C and D vary respectively from 10.82 to 12.54 %, from 9.01 to 7.34 % and by 0.71 to 0.98 %. The moisture contents, of proteins and lipids of the flours decrease with the increase in the rate of incorporation of the flour taro. However, the ash contents and of glucides total increase with the rate of incorporation in flour of taro. The ash contents and of glucides total vary from 0.83 to 2.45 % and 76.64 to 79.63 % The caloric intake total (ACT) and the energy density (DE) of various formulations of biscuits are respectively 529.78 to 531.42 Kcal and by 401.35 to 402.59 Kcal / 100 g. the caloric intake total (ACT) and the energy density (DE) decreases with the contribution of the flour of taro. The sensory analysis of biscuits at base of the four (04) formulations of the composite flours A, B, C and D showed the satisfactory results as a whole.

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INTRODUCTION

Congo has agricultural potentialities enormous and varied thanks to its équato-tropical climate. Unfortunately, this capital is insufficiently exploited and makes the country dependent on the imports of the foodstuffs to satisfy the food needs for its population. This dependence is marked in the field of starchy foods, the lipids and the products proteinic. The food consumption surveys carried out in Congo by Silou and *Al (*2004 showed a strong consumption of the glucidic products to the detriment of food protidic. These studies highlighted average energy contributions ranging between 1900 and 2500 cal / J / individual. Among the agricultural resources of Congo, there is the tuber of taro (*Colocasia esculenta* , which is a primarily glucidic food.

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The starch is its component major characterized by grains of size C omprise between 2,5 and 17 µm (Dadie and Al 1998). Intolerance with glucose remains a handicap for the alive people with L are diseases the such diabetes and L ' obesity to consume the products containing sugar (saccharose). According to (Atlas IDF, 2017 5 million people died following the diabetes into 2015. This disease is related on obesity, hypertension and the cardiovascular diseases. Sugar resulting from Stévia (*rebaudiana bertoni* is a natural sugar without calorie with a capacity sweetening going from 200 to 300 times higher than that of saccharose (Sério, 2010). The objective of work is to work out dietetic biscuits at base of the composite flours of taro (*Colocasia esculenta* / corn in substituent sugar by Stévia (*rébaudiana bertoni).*

MATERIELS AND METHODS

Sampling and production of the flours made up corn / taro and development of dietetic biscuits: The flour of taro

(*Colocasia esculenta* used was produced as described on Fig.1 The tubers of taro were collected with maturity (between 8-9 month) in a country field of the village Kindamba (area of the pool) located at the South of Congo. The flour of corn was bought in a local supermarket of the town of Brazzaville manufactured by the Flour mill of Congo (MINOCO). The two flours (flours of taro and corn) made it possible to work out the flours made up taro / corn of the type A, B, C and D by substitution partial of the flour of corn by that of the taro (Table 1). The composite flours obtained were sealed in the polyethylene sachets and were preserved at 4°C in a refrigerator before the use.

Diagram of manufacture of dietetic biscuits at base of the composite flours taro / corn: The biscuits were manufactured starting from the diagram proposed by Benkadri, 2010 (Fig.2). The kneader of mark SHARP EMS – 51 L (w) Japan was used to prepare the various pastes after proportioning of the ingredients. A volume of distilled water containing salt (sodium chloride) was then versed. The flour mixed beforehand with the raising agent (Brewers' yeast) was introduced in the last. After mixture of all the ingredients, the operations of clothes industry were carried out; it acts of the operations of kneading, working of the lumps. The lumps were then incubated (put at rest) to 25 °C during 20 minutes. After incubation, the lumps were cooked with 220 ±10 °C during 7 minutes, and then the biscuits were cooled with the free air during 30 min and preserved at the ambient temperature

Characterization of the various formulations of biscuits: The total caloric intake (ACT), the energy density (DE)and the nutritional density (DN) were calculated by the formulas suggested by Favier *et al.,* 1995 and Namous, 2013.

Total caloric intake (ACT): The total caloric intake (ACT) of the biscuitières formulations was calculated starting from the energy ingredients entering the composition of each one, expressed in kcal according to the following formula:

ACT = contribution of the composite flour + contribution of the margarine + contribution of sugar (1)

- The calorific contribution of the composite flours (corn and taro) is given starting from their biochemical composition.
- The energy contribution of the margarine is given by taking account of the coefficients of ATWATER corresponding to one gram of lipids (9 kcal) and a gram of proteins or glucides (4 kcal) (Cox, 2005) were used for the conversion of the energy quantities of nutriments into energy.
- The energy contribution of sugar is equal to the quantity of sugar added in the formula multiplied by the coefficient 3.9 which constitutes the energy content of one gram saccharose. In our case, this contribution is null because the sugar used in this work is not heating.

Energy density (DE): The energy density (OF) is expressed in kcal / 100 g of product. It is estimated by the following formula:

$$DE = (ACT * 100) / (QFC+QS+QSh) \quad (2)$$

Where: DE: energy density (kcal / 100 g);
ACT: Total Calorific contribution (kcal);
QFC: quantity of the composite flour (g);
QS: quantity of added sugar (g);
QSh: quantity of the fat content added (g);

Sensory Evaluation: The sensory evaluation makes it possible to define, measure, analyze and interpret the characteristics of a product perceived by the intermediary of the bodies of the directions, i.e. its properties gustatory, olfactive, visual, auditive and tactile. Certain standards as follows define simply the sensory analysis: examination of the organoleptic properties of a product by the bodies of the directions (Claustriaux, 2001). The test of sensory evaluation selected for our biscuits is a test hedonic. The tests hedonic are conceived to measure the degree of appreciation of a product. One is useful oneself of scales of categories going of " likes much " with " does not like at all " while passing by " neutral " with a variable number of intermediate categories. The tasters choose, for each sample, the category which corresponds to their degree of appreciation (Watts et al., 1991).

The jury was composed of fourteen (14) tasters chosen randomly among the teachers and the students of the Polytechnic Higher National School of University Congo Brazzaville. The selected descriptors are as follows: color, odor, taste and friability with a scale on five (05) levels. Preliminary instructions and explanations were given to the tasters before each series of tasting. They consisted in rendering comprehensible them the mode of attribution of the notes to biscuits by descriptors. Each taster was provided with four (4) samples of biscuits coded with random numbers with three (03) digits and of water glass. The direction of tasting was left towards the line. The tasters were to indicate their going degree of appreciation on a scale of the notes from 1 to 5 levels for each descriptor.

Test ANOVA and that of multiple extents (method To card-index LSD) were also applied to check the exactitude of the results. The descriptive categories were converted into numerical notations after their evaluation.The collected data made it possible to make following calculations:

Factor of correction (FC):

$$FC = (\text{Great total})^2/(N) \quad (5)$$

Where N is the total number of individual answers. It is equal to the number of tasters multiplied by the number of product.

Total sum of the squares:

$$SC(T) = \sum (\text{answer of each individual})^2 - FC \quad (6)$$

Summon squares of the treatments:

$$SC(tr) = \{\sum(\text{total of each treatment})^2/(\text{a number of response by treatment})\}-FC \quad (7)$$

Summon squares of the tasters:

$$SC(D) = \{\sum (\text{total of each taster})^2/(\text{a number of answer per taster})\}- FC \quad (8)$$

Summon squares of the errors:

$$SC(E) = SC(T) - SC(tr) - SC(D) \quad (9)$$

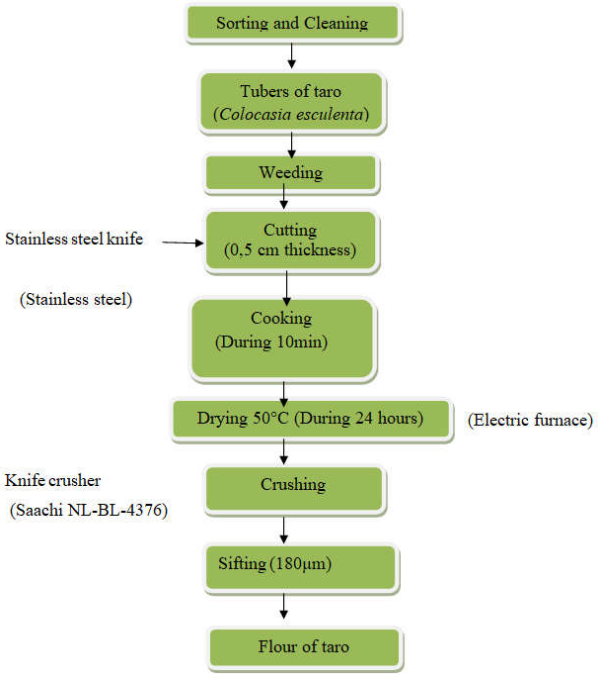

Fig.1.Diagram of manufacture of the flour of taro

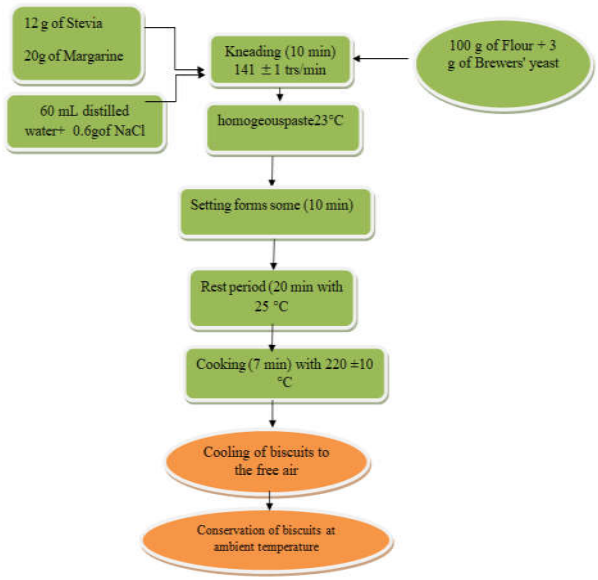

Fig.2. Diagram of manufacture of dietetic biscuits containing corn of the composite flours taro/blé

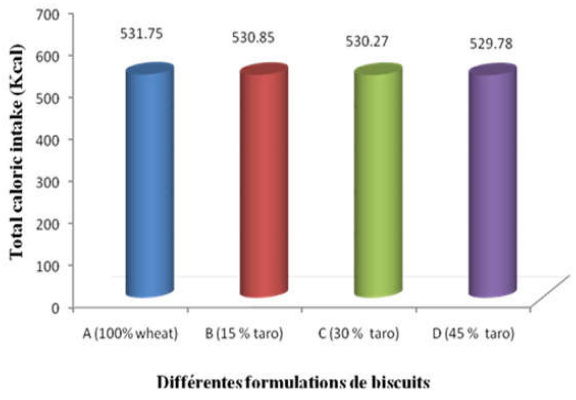

Fig.3. Total caloric intake (ACT) of our formulated cookies wheat and taro

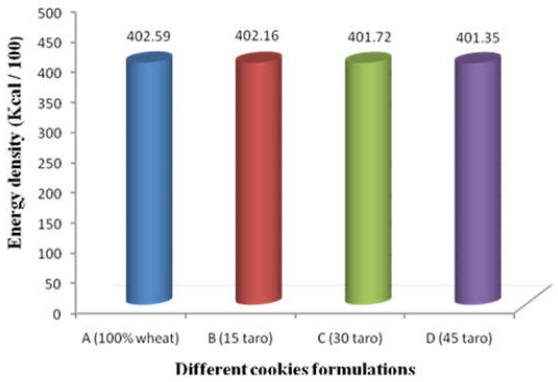

Fig. 4. Energy densities (DE) of the formulated cookies wheat and taro

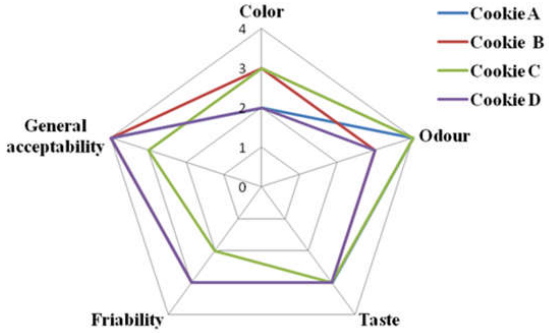

Fig. 5. Sensory profile of the four formulated cookies

Average squares: the average squares (CM) were calculated by dividing the values of the sums of squares (SC) by their respective degrees of freedom (dl) as follows:

Total degrees of freedom, dl (T) = the total Number of answers – 1 (10)

Degrees of freedom treatments, dl (tr) = the total Number of treatments –1 (11)

Degrees of freedom of the tasters, dl (D) = the total Number of tasters –1 (12)

Degrees of freedom of the errors, dl (E) = dl (T) – dl (tr) – dl (D) (13)

Average square of the treatments:

$$CM = SC(tr) / dl(tr) \quad (14)$$

Average square of the tasters:

$$CM(D) = SC(D) / dl(D) \quad (15)$$

Average square of the errors:

$$CM(E) = SC(E) / dl(E) \quad (16)$$

Coefficients F: The coefficients F of treatments and the tasters were calculated by dividing the respective values of average square by the average square of the error. The calculated coefficients F are considered significant at the time their values are higher than the values of D istribution of F to a threshold of 5 %.

Statistical analyses: The data announced in all the tables and figure are values of averages determined in triple. They were subjected to a variance analysis (ANOVA) and to tests of multiple extents by the method of Fisher (LSD) in order to classify the samples at the significant level of 5% by using the software Statgraphics XVII Centurion Version 17.1.12 (Statpoint technologies, Inc the USA). The software Excel 2007 and Minitab was used for the layout of the curves.

RESULTS AND DISCUSSION

Physico-chemical composition of the various formulations of made up flours: The physico-chemical composition of the made up flours is presented in table 2.The moisture contents, of proteins and lipids of the flours of the composite flours containing taro/blé of type A, B, C and D vary respectively from 10.82 to 12.54 %, from 9.01 to 7.34 % and by 0.71 to 0.98 %. The moisture contents, of proteins and lipids of the flours decrease with the increase in the rate of incorporation of the flour taro. However, the ash contents and of glucides total increase with the rate of incorporation in flour of taro. The ash contents and of glucides total vary from 0.83 to 2.45 % and from 76.64 to 79.63 %.

Table 1. Various flours obtained and codes used

Made up flours (%)	Flour of corn (%)	Flour of taro (%)	Codes
100 : 0	100	0	A
85 : 15	85	15	B
70 : 30	70	30	C
55 : 45	55	45	D

Table 2. Physico-chemical composition of the made up flours

Formulations	Moisture (%)	Proteins (%)	Lipids (%)	Ashes (%)	Glucides totals (%)
A (100% corn)	12.54	9.01	0.98	0.83	76.64
B (85 %blé -15% taro)	11.89	8.17	0.85	1.37	77.63
C (70%blé – 30% taro)	11.4	7.34	0.71	1.91	78.63
D (55%blé – 45% taro)	10.82	6.51	0.58	2.45	79.63

Table 3. Notes of various biscuitières formulations allotted by the tasters

Formulations of biscuits	Color	Odor	Taste	Friability	General acceptability
Biscuit A	2 ± 1.20^{a}	4 ± 1.18^{a}	3 ± 1.08^{a}	3^{a}	4^{c}
Biscuit B	3^{a}	3^{a}	3^{a}	3^{a}	4^{b}
Biscuit C	3^{a}	4^{a}	3^{a}	2^{a}	3^{d}
Biscuit D	2^{a}	3^{a}	3^{a}	3^{a}	4^{a}

The variation of these physico-chemical parameters with the rate of incorporation of the flour of taro can be explained by the richness of the composition of the flour of rock salt and starch taro (Nguimbou, 2012; Panyoo, 2014; Aboubakar, 2009). According to the standard Codex Stan 152-1995, 7 % corresponding at least to the content of the flour corn. Thanks to the contribution of the flour of corn; the made up flours B and C could make it possible to make up the proteinic deficit and to be used in the manufacture of biscuits. On the other hand the content of protein of the flour D is slightly below this standard. Indeed the manufacture of biscuits requires a content of proteins located between 7.5 % and 9.0 % (Fustier, 2006).

Caloric intake total and energy density of the made up flours: The results of the total caloric intake (ACT) and of the energy density (DE) are presented respectively on figures 3 and 4. The caloric intake total (ACT) and the energy density (DE) of various formulations of biscuits vary respectively from 529.78 to 531.42 Kcal and from 401.35 to 402.59 Kcal / 100 g. One notes that values of the caloric intake total (ACT) and by the energy density (DE) decrease with the contribution of the flour of taro. Aren't the differences in variation between biscuits significant with $P<0.05$. The various biscuitières formulations obey to the standard emitted by FAO This caloric intake total is certainly standardized thanks to the presence of the stévia where the sugar caloric intake is null. The energy densities obtained are lower than those presented by (Namous, 2013) but close to those obtained by Benkadri, 2010 and Toulsoumdé et al., 2016 respectively on biscuits without gluten containing rice and of biscuits at base of the rolled flours (produced cereal dry loans with employment obtained by agglomeration of the particles of flour or semolina hydrated between them).According to the Codex Stan 203 –1995, a food preparation for food mode with very energy low value must provide, a daily caloric intake of 450-800 kcal.These results are in agreement with those obtained by Lutter et al*.,* 2003. Indeed, for these authors the energy density (DE) must be higher or equal to 440 Kcal/100g.

Sensory evaluation: The results of the sensory evaluation and the test of ANOVA of biscuits containing composite flour taro/blé are presented respectively in table 3 and on Fig.5 and in table 4. The results show the biscuits which biscuits obtained at base formulation A, B, and D were better appreciated by the panel of tasters on the descriptors such as the friability, the taste and the odor. Indeed, for Himeda *et al.,*,2012a, the limit of substitution of the flour of taro must be 40% for a better acceptability of biscuits. The addition complementary to 5 % of this flour did not limit the appreciation to close to the tasters. It could be that sugar containing Stévia improves to a significant degree the acceptability of biscuits containing the flour of taro. These results were also confirmed by the test of distribution of the coefficient of the value F. The coefficients of F of the treatments and the tasters are respectively 2.3 and 1.98. Although the coefficient F calculated of the treatments was higher conversely, that of the coefficient F calculated of the tasters being lower than the coefficient F of the threshold of significativity between the four (04) formulations of biscuits.

It was not necessary to determine the multiple test of comparison of Duncan.

Conclusion

The parameters of physico-chemical quality such as the moisture content, of proteins and lipids of the composite flours containing taro/corn decrease with the rate of incorporation in flour of taro. However, one notes an increase in the ash content and of glucides total with the rate of incorporation in flour of taro. The caloric intake total (ACT) and the energy density (DE) of various formulations of biscuits are respectively 529.78 to 531.42 Kcal and 401.35 to 402.59 Kcal /100 g. The incorporation of the stevia which is a natural sugar (without caloric intake) in the place of saccharose made it possible to minimize the caloric intake sweetens some in biscuits. The energy contributions of biscuits respect strictly the standards imposed by FAO/OMS **(**Codices stan 203 –1995)on diet foods. According to these standards, a dietetic food preparation or of mode with very energy low value must provide a caloric intake of 450-800 kcal with an energy density which should be higher or equal to 440 Kcal/100g. The sensory analyses of biscuits at base of the four (04) formulations of the composite flours taro/corn showed the satisfactory results as a whole.

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