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Organoleptic Characteristics of Selected Traditional Foods Made from A Composite Flour of Type 45 Wheat (*Triticum aestivum*) and Taro (*Colocasia esculenta*) Corm (cv. Fouê and Yatan): The Case of Spring Rolls, Snowballs, and Savory Croquettes

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ABSTRACT

The wheat flour used in pastry production in Côte d'Ivoire is exclusively imported, resulting in a significant dependence on wheat-producing countries. Furthermore, given the continuous growth of the world population and the persistent problem of undernutrition among African populations, there is a need to substitute or combine wheat flour with locally available flour resources in order to reduce the quantity of imported wheat. In this context, the present study investigated the use of taro corm flour in combination with Type 45 wheat flour for the preparation of pastry products. The pastry products developed in this study were nems, snowball pastries, and savory croquettes. The experimental formulations consisted of composite flours combining Type 45 wheat flour with taro corm flour from the cultivars "Fouê" and "Yatan." The wheat flour was substituted with taro corm powder at substitution levels of 1%, 3%, 6%, 9%, and 12%. A formulation containing 100% Type 45 wheat flour was used as the control. The organoleptic characteristics and consumer acceptability of the prepared products were evaluated through sensory analysis. The results showed that all products prepared with 1%, 3%, and 6% taro corm flour substitution were well accepted by the panelists. These products exhibited organoleptic characteristics very similar to those of the 100% wheat flour control. However, lower acceptability was observed for products containing 9% and 12% substitution of wheat flour with taro corm powder from the "Fouê" and "Yatan" cultivars. Overall, the findings indicate that taro corm powders from the "Fouê" and "Yatan" cultivars have potential as partial substitutes for wheat flour in the production of modern pastry products.

Introduction

In recent years, food security has become a global concern due to climate change, which is one of the major factors contributing to the increase in international food prices (Capone *et al.,* 2016). Today, approximately 1.02 billion people are considered undernourished (FAO, 2009). It is therefore evident that food production must increase substantially to meet the future needs of a growing population, which is expected to reach approximately 9 billion by 2050 (Camel, 2018). The rapid urbanization of Africa and the emergence of a middle class are changing dietary habits and increasing the consumption of bread and traditional foods that require greater valorization (Camel, 2018).

Wheat flour is a basic ingredient in pastry and bakery products and is also used in the preparation of several traditional foods. The widespread use of wheat is associated with the ability of wheat dough to retain gas, thereby allowing the dough to expand during baking (Gan *et al.,* 1995). The cost of importing wheat and wheat-derived products places a considerable burden on the trade balance of countries that import wheat but do not produce it domestically. In developing countries, particularly in sub-Saharan Africa, research efforts have focused on the partial substitution of wheat flour with locally available food flours (Shittu *et al.,* 2007). This approach aims to reduce costly wheat imports while increasing the utilization of locally produced food resources (Ikpeme *et al.,* 2010).

Studies addressing composite wheat flours blended with other food products indicate that their use in breadmaking, pastry production, and the preparation of traditional foods is a relatively recent development worldwide. According to the region, three major factors appear to justify this development: economic, social, and health-related considerations (Shittu *et al.,* 2007). Consequently, research has increasingly focused on the production of composite flours from locally available crops as alternatives to wheat. Several authors have investigated the development of composite flours in which part of the wheat flour is replaced with other starchy sources (Berthelot, 1990; Defloor, 1995).

Accordingly, attempts to substitute wheat flour with flours or powders derived from locally available carbohydrate-rich products, such as cereals (maize, rice, sorghum, and millet), tubers (cassava, taro, sweet potato, and yam), and protein-rich crops (cowpea and soybean), have yielded promising results (Begum *et al.,* 2013; Bibiana *et al.,* 2014; Trejo-González *et al.,* 2014). These studies indicate that the quality of the resulting products depends on the proportional composition of the composite flours and their functional properties (Oladunmoye *et al.,* 2010).

Several studies have contributed to the understanding of the physicochemical and nutritional properties of taro powder (Njintang *et al.,* 2006, 2007, 2008; Aboubakar *et al.,* 2009, 2010). Earlier studies on taro showed that substitution of wheat flour with up to 10% raw taro powder did not significantly affect the rheological properties of the dough (Njintang *et al.,* 2008). Certain physical characteristics of food products, such as appearance and surface colour, are generally among the first quality parameters evaluated by consumers and play an important role in product acceptance (Pedreschi *et al.,* 2006).

Therefore, the objective of the present study was to investigate the organoleptic characteristics of selected traditional pastry products prepared using composite flour consisting of Type 45 wheat flour (*Triticum aestivum*) and taro corm powder (*Colocasia esculenta*) from the "Fouê" and "Yatan" cultivars. The products investigated were nems, snowball pastries, and savory croquettes.

More specifically, the study aimed to:

- formulate composite flours based on wheat flour and powders obtained from the "Fouê" and "Yatan" taro cultivars at appropriate proportions;
- prepare traditional pastry products, namely African nems, snowball pastries, and savory croquettes, using these composite flours; and
- evaluate the acceptability of these products through sensory analysis.

Materials and Methods

Materials

Biological Material

The biological materials used in this study consisted of Type 45 (T45) wheat flour and corm powders obtained from two taro cultivars (*Colocasia esculenta*), namely "Fouê" and "Yatan." The T45 wheat flour was purchased from a supermarket in the city of Abidjan (Figure 1).

The taro materials consisted specifically of corms from a purple-fleshed cultivar (Figure 2) and a white-fleshed cultivar (Figure 3), locally known as "Fouê" and "Yatan," respectively, in Akyé, a local language spoken by the Lagoon peoples belonging to the Akan group in Côte d'Ivoire.

The corms were harvested at physiological maturity, following the drying of the leaves and stems, from plantations in Afféry, a commune in the Akoupé Department, located in southeastern Côte d'Ivoire. A total of 100 kg of "Fouê" corms and 80 kg of "Yatan" corms were collected. The corms were transported the following day from the harvesting site to the Laboratory of Biocatalysis and Bioprocesses, Unit of Training and Research in Food Sciences and Technologies, Nangui Abrogoua University, Abidjan, Côte d'Ivoire, where the experimental studies were conducted.

Technical Equipment

The technical equipment used in this study consisted of laboratory equipment routinely employed for biochemical analyses. The equipment included a LE PROVENCAL AU SABOT 392355 stainless-steel knife, a MOULINEX K1011014 grater, a MEMMERT 854 ventilated drying oven (Sewabach, Germany), a COOK WORKS SILVER GLASS BLENDOR blender, a SMAUTOP B07TT5J3J2 electric rotating porcelain mortar, a MATFER 500 µm stainless-steel sieve, a MOULINEX ABM 11A30 electric whisk, an OXO 1126980 manual whisk, and a FAURE FCG510G1WA gas cooker.

Other Food Ingredients

The food ingredients used in this study included salt (sodium chloride), yeast (*Saccharomyces cerevisiae*), sugar (sucrose), CALVE butter, PRINCESSE sweetened condensed milk, DINOR palm oil, fish, onions, garlic, and eggs. All ingredients were purchased from a supermarket in Abidjan, Côte d'Ivoire.

Methods

Procedure for Obtaining Taro Flour

The taro corms were washed thoroughly with water, peeled, and cut into two halves. The pieces were subsequently grated to obtain thin slices (chips). These slices were dried in a ventilated oven at 50 °C for 72 hours (3 days). The resulting dried slices were first ground using a blender and subsequently further pulverized using an electric rotating mortar.

The resulting taro flours (Figure 3) were then sieved and stored in clean plastic containers that were tightly sealed. The taro powder was prepared according to the process flow diagram presented below.

Wheat–Taro Composite Flours

Wheat–taro composite flours were formulated by partially replacing wheat flour with taro corm flour obtained from *Colocasia esculenta* cultivars "Yatan" or "Fouê" at substitution levels of 1%, 3%, 6%, 9%, and 12%. For each formulation, 3 kg of composite flour was prepared, and the exact masses of the individual flours used according to the respective substitution levels are presented in Table I.

The composite flours were thoroughly mixed manually to ensure uniform distribution of the components.

The resulting flours were then transferred into appropriate storage containers for subsequent analyses and for the preparation of the pastry products, namely nems, savory croquettes, and snowball pastries.

The composite flours prepared by incorporating taro powder from the "Yatan" cultivar were designated Yatan 1%, Yatan 3%, Yatan 6%, Yatan 9%, and Yatan 12%, corresponding to the respective levels of wheat flour substitution. Similarly, the composite flours prepared using taro powder from the "Fouê" cultivar were designated Fouê 1%, Fouê 3%, Fouê 6%, Fouê 9%, and Fouê 12%. The control formulation was designated T45 wheat flour (100% wheat) (Table II).

Preparation of Traditional Pastry Products

The flour formulations obtained were used to prepare selected traditional pastry products.

Preparation of Nems

First, the filling sauce was prepared. The fish was deboned and then crushed in a mortar together with onion, garlic, green onion, and cabbage. The ingredients were thoroughly mixed to obtain the filling sauce.

Second, the ingredients required for the dough were successively placed in an aluminum bowl and manually kneaded for a total of 8 min. First, the flour was added, followed by baker's yeast and water. The mixture was manually kneaded thoroughly for 3 min. Butter was then added, followed by an additional 5 min of kneading to obtain the dough.

Once the dough was prepared, it was flattened on a board and cut into pieces using a knife. Approximately 0.5 g of the prepared filling sauce was placed on each dough piece. The pieces were then rolled and deep-fried in oil for 7 min.

The resulting fried African nems were transferred to trays and allowed to cool at room temperature for 10 min before labeling and packaging (Figure 4).

The same procedure was followed for all flour formulations, including the 100% T45 wheat flour control, as well as the Yatan formulations (1%, 3%, 6%, 9%, and 12%) and Fouê formulations (1%, 3%, 6%, 9%, and 12%) (Table III).

Preparation of Snowball Pastries

The ingredients required for the dough were successively added to an aluminum bowl and manually kneaded for a total of 8 min. First, baker's yeast, chemical leavening agent, nutmeg, milk, oil, and eggs were added to the composite flour. The mixture was thoroughly kneaded manually for 8 min to obtain the dough.

The resulting dough was manually shaped into small balls, which were then deep-fried in oil in an aluminum saucepan for 7 min. The cooked snowball pastries were subsequently allowed to cool at room temperature for 10 min in trays before being labeled and packaged (Figure 5).

The same preparation procedure was applied to all formulations, namely the 100% T45 wheat flour control, Yatan formulations (1%, 3%, 6%, 9%, and 12%), and Fouê formulations (1%, 3%, 6%, 9%, and 12%) (Table IV).

Preparation of Savory Croquettes

The onion and garlic were blended together. Fifty (50) grams of the onion–garlic mixture was weighed and used for each formulation. In a stainless-steel bowl, flour, water, oil, salt, and 50 g of the onion–garlic mixture were combined. The ingredients were manually kneaded for 5 min to obtain a dough.

The resulting dough was flattened and rolled out on a board, then cut into small cubes using a knife. The dough cubes were subsequently deep-fried in oil for 5 min. After frying, the savory croquettes were removed from the oil and placed in trays. They were allowed to cool at room temperature for 10 min before being labeled and packaged (Figure 6).

The same preparation procedure was applied to all formulations, namely the 100% T45 wheat flour control, Yatan formulations (1%, 3%, 6%, 9%, and 12%), and Fouê formulations (1%, 3%, 6%, 9%, and 12%) (Table V).

Sensory Analysis of the Prepared Products – Tasting Test

Sensory analysis was conducted using the quantitative descriptive analysis (QDA) method described by Watts *et al.,* (1991). The samples, identified by three-digit codes, were presented to the panelists in a randomized order (Watts *et al.,* 1991). The analysis involved evaluating and quantifying relevant sensory descriptors, including crust colour, crust and crumb texture, taste, flavour, and overall acceptability, using an intensity scale.

A panel of 15 individuals trained in the descriptive analysis of the organoleptic characteristics of the products was established for this purpose. The 15 panelists, comprising both men and women, participated in the evaluation.

The assessment focused on the general characteristics of the crust (texture and colour) and crumb (appearance, colour, alveolation, and uniformity), as well as taste, flavour, and overall acceptability.

This method enabled the 15 trained panelists to evaluate the sensory characteristics of the different products prepared using the experimental and control flour formulations. Each panelist assigned a score based on a 0–10 scale. The scores obtained were used to construct sensory profile curves for the different products.

Finally, the acceptability assessment was used to generate overall acceptability graphs for the traditional products evaluated.

Data Processing

The proportions were calculated, and graphs were generated for each product and each taro cultivar using Microsoft Excel 2016.

Results and Discussion

The traditional pastry products, namely nems, snowball pastries, and savory croquettes, were prepared using ten composite flour formulations containing taro powder from either the “Fouê” or “Yatan” cultivars. The control product was prepared using 100% Type 45 (T45) wheat flour.

Appearance and Characteristics of the Wheat–Taro Composite Flours Obtained According to Taro Cultivar

The 100% T45 wheat flour exhibited a very white colour. When wheat flour was partially substituted with taro powder from the “Fouê” or “Yatan” cultivars, the colour of the resulting composite flour became brownish. The composite flour prepared with the “Fouê” cultivar exhibited a darker reddish colour than that prepared with the “Yatan” cultivar. Furthermore, as the substitution level increased, the composite flour progressively became darker in colour (Figure 7).

Production of Traditional Pastry Products

Nems

The African nems prepared with the 100% Type 45 wheat flour control exhibited a light yellow colour and a very light appearance. When T45 wheat flour was partially substituted with taro powder at substitution levels of up to 6%, the resulting African nems exhibited a colour and appearance similar to those of the control for both the “Fouê” and “Yatan” cultivars. At substitution levels of 9% and 12%, the nems exhibited a darker yellow colour and a less light appearance for both cultivars (Figure 8).

Snowball Pastries

The snowball pastries prepared with the 100% Type 45 wheat flour control exhibited a light yellow colour and a light appearance. When T45 wheat flour was partially substituted with taro powder at substitution levels of up to 6%, the resulting snowball pastries showed a colour and appearance similar to those of the control.

At substitution levels of 9% and 12%, the colour became darker yellow in the “Yatan” cultivar. In the case of the “Fouê” cultivar, beyond a taro powder substitution level of 1%, the snowball pastries developed a dark yellow colour. This colour became progressively darker and tended toward reddish tones as the substitution level increased to 12%.

For both cultivars, increasing the taro powder substitution level resulted in a progressively less light appearance of the snowball pastries (Figure 9).

Savory Croquettes

The savory croquettes prepared with the 100% Type 45 wheat flour control exhibited a light yellow colour and a light appearance. When T45 wheat flour was partially substituted with taro powder at substitution levels of up to 6%, the resulting savory croquettes showed a colour and appearance similar to those of the control.

At substitution levels of 9% and 12%, the croquettes prepared with the “Fouê” cultivar exhibited a darker yellow colour. In contrast, those prepared with the “Yatan” cultivar maintained a light yellow colour similar to that of the control, even at the 12% substitution level.

For both cultivars, increasing the taro powder substitution level resulted in a progressively less light appearance of the savory croquettes (Figure 10).

Sensory Profiles of Traditional Products Prepared with Composite Flours Containing “Fouê” and “Yatan” Taro Cultivars

The sensory profiles of the traditional products were represented using radar charts, based on the mean scores (0–10) assigned by the panelists to the different sensory descriptors. Attributes such as colour, aroma, texture, and taste were the most perceptible characteristics across all evaluated product samples.

When T45 wheat flour was substituted with taro powder at levels of up to 6%, the sensory attributes evaluated were similar to those of the 100% T45 wheat flour control. The greatest deviations from the control were observed in samples containing taro powder from the “Fouê” and “Yatan” cultivars at substitution levels of 9% and 12%.

Nems

The sensory profiles of African nems prepared with wheat–"Fouê" composite flour (Figure 11) and wheat–"Yatan" composite flour (Figure 12) showed that the intensity of the sensory descriptors increased progressively with increasing substitution of wheat flour by taro powder. Thus, attributes such as aroma, taste, flavour, and colour became increasingly perceptible.

With the addition of taro powder from the "Fouê" and "Yatan" cultivars, samples containing up to 6% taro powder exhibited organoleptic characteristics close to those of the 100% T45 wheat flour control. From the 9% substitution level, the organoleptic characteristics became markedly different from those of the control, and the taro taste became more pronounced.

Regarding the crust and crumb colours, they became progressively darker as the substitution level increased (Figures 13 and 14).

Snowballs

The sensory profiles of the snowballs prepared from wheat–"Fouê" and wheat–"Yatan" composite flours, presented as radar charts, are shown in Figures 13 and 14, respectively.

Overall, the intensity of the sensory responses increased when the substitution level reached 9%. Thus, attributes such as aroma, taste, and colour became more perceptible from the 9% substitution level with taro powders from both the "Fouê" and "Yatan" cultivars.

For both the "Fouê" and "Yatan" taro cultivars, no marked differences were observed in most of the organoleptic parameters, except for taro taste and aroma, which became increasingly perceptible as the substitution level increased. Overall, the organoleptic characteristics of the products remained relatively close to those of the 100% T45 wheat flour control, except for the products prepared with 9% and 12% taro powder (Figures 13 and 14).

Savory Croquettes

The sensory profiles of the savory croquettes prepared with wheat–"Fouê" composite flour (Figure 15) and wheat–"Yatan" composite flour (Figure 16), presented as radar charts, showed that the overall intensity of the sensory responses increased substantially at substitution levels of 9% and above. Consequently, attributes such as aroma, taste, flavour, and colour became more pronounced.

The products prepared with taro flour from the "Fouê" and "Yatan" cultivars at substitution levels of up to 6% exhibited similar sensory intensities.

However, from 9% substitution onwards, the organoleptic characteristics were markedly altered, with particularly high intensities observed for taste and aroma (Figures 15 and 16).

Substitution of 9% and 12% of Type 45 wheat flour with taro powder from the "Fouê" and "Yatan" cultivars substantially affected the organoleptic properties of the resulting products, particularly with respect to aroma and taste.

Overall Acceptability of Traditional Products Prepared with Composite Flours Containing "Fouê" and "Yatan" Taro Powders

Acceptability of Traditional Nems Prepared with Wheat–"Fouê" and Wheat–"Yatan" Composite Flours

Overall acceptability was evaluated using a three-point scale: *unacceptable, less acceptable, and acceptable* for the nems prepared with wheat–"Fouê" and wheat–"Yatan" composite flours.

The nems were well appreciated and accepted up to a substitution level of 6%. At substitution levels of up to 6%, the acceptability of the nems prepared with "Yatan" taro flour (>80%) was higher than that of the nems prepared with "Fouê" taro flour (approximately 40%).

However, from the 9% substitution level, the traditional nems became less acceptable, while at the 12% substitution level, they were considered unacceptable by the panelists (Figures 17 and 18).

Table.1 Proportions of wheat flour substituted with taro (Colocasia esculenta) corm powder from the "Yatan" and "Fouê" cultivars.

Taro cultivar	Substitution level	Taro powder (g)	T45 wheat flour (g)	Wheat–taro composite flour (g)
"Yatan" or "Fouê"	1%	30	2,970	3,000
"Yatan" or "Fouê"	3%	90	2,910	3,000
"Yatan" or "Fouê"	6%	180	2,820	3,000
"Yatan" or "Fouê"	9%	270	2,730	3,000
"Yatan" or "Fouê"	12%	360	2,640	3,000
Control	**0%**	**0**	**3,000**	**3,000**

Table.2 Identification of the different types of composite flours formulated according to the proportions of added taro flour.

Flour Type	Code / Identification	Description
Control	**FBT – Control 100% wheat**	Control wheat flour (100% wheat)
"Fouê" 1%	**FCF1**	Composite flour containing 99% wheat flour and 1% taro powder from the "Fouê" cultivar
"Fouê" 3%	**FCF3**	Composite flour containing 97% wheat flour and 3% taro powder from the "Fouê" cultivar
"Fouê" 6%	**FCF6**	Composite flour containing 94% wheat flour and 6% taro powder from the "Fouê" cultivar
"Fouê" 9%	**FCF9**	Composite flour containing 91% wheat flour and 9% taro powder from the "Fouê" cultivar
"Fouê" 12%	**FCF12**	Composite flour containing 88% wheat flour and 12% taro powder from the "Fouê" cultivar
"Yatan" 1%	**FCY1**	Composite flour containing 99% wheat flour and 1% taro powder from the "Yatan" cultivar
"Yatan" 3%	**FCY3**	Composite flour containing 97% wheat flour and 3% taro powder from the "Yatan" cultivar
"Yatan" 6%	**FCY6**	Composite flour containing 94% wheat flour and 6% taro powder from the "Yatan" cultivar
"Yatan" 9%	**FCY9**	Composite flour containing 91% wheat flour and 9% taro powder from the "Yatan" cultivar
"Yatan" 12%	**FCY12**	Composite flour containing 88% wheat flour and 12% taro powder from the "Yatan" cultivar
"Fouê" composite	**FCF**	Composite flour containing taro powder from the "Fouê" cultivar
"Yatan" composite	**FCY**	Composite flour containing taro powder from the "Yatan" cultivar

Table.3 Ingredients used for the preparation of control and experimental nems.

Ingredients	Control	Fouê formulations	Yatan formulations
T45 wheat flour (100% wheat)	200 g	0	0
Composite flour	0	200 g	200 g
Fish	50 g	50 g	50 g
Water	100 mL	100 mL	100 mL
Butter	60 g	60 g	60 g
Baker's yeast	5.5 g	5.5 g	5.5 g
Onion	1	1	1
Garlic	1 clove	1 clove	1 clove
Green onion	5 g	5 g	5 g
Cabbage	1.5 g	1.5 g	1.5 g

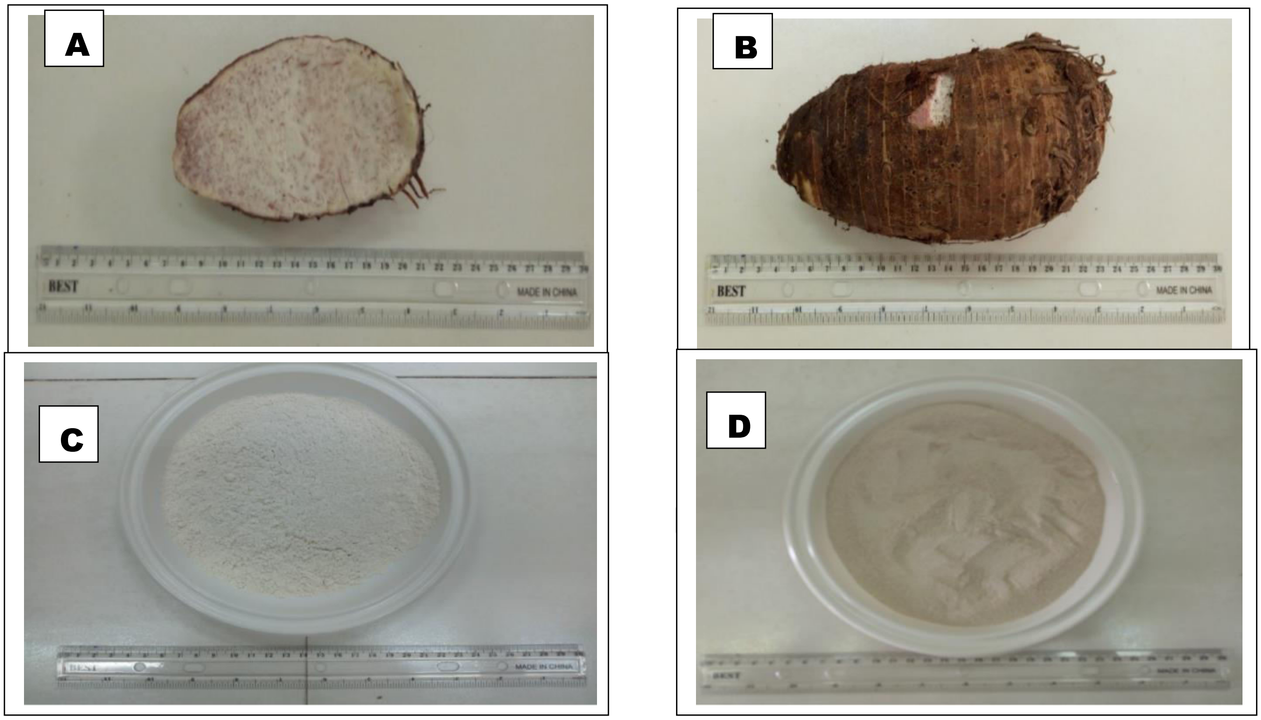
Table.4 Ingredients used for the preparation of control and experimental snowball pastries.

Ingredients	Control	Fouê formulations	Yatan formulations
T45 wheat flour (100% wheat)	400 g	0	0
Composite flour	0	400 g	400 g
Nutmeg	0.56 g	0.56 g	0.56 g
Baking powder	1 sachet	1 sachet	1 sachet
Baker's yeast	1 sachet	1 sachet	1 sachet
Oil	200 mL	200 mL	200 mL
Milk	200 mL	200 mL	200 mL
Eggs	3	3	3

Table.5 Ingredients used for the preparation of control and experimental savory croquettes**.**

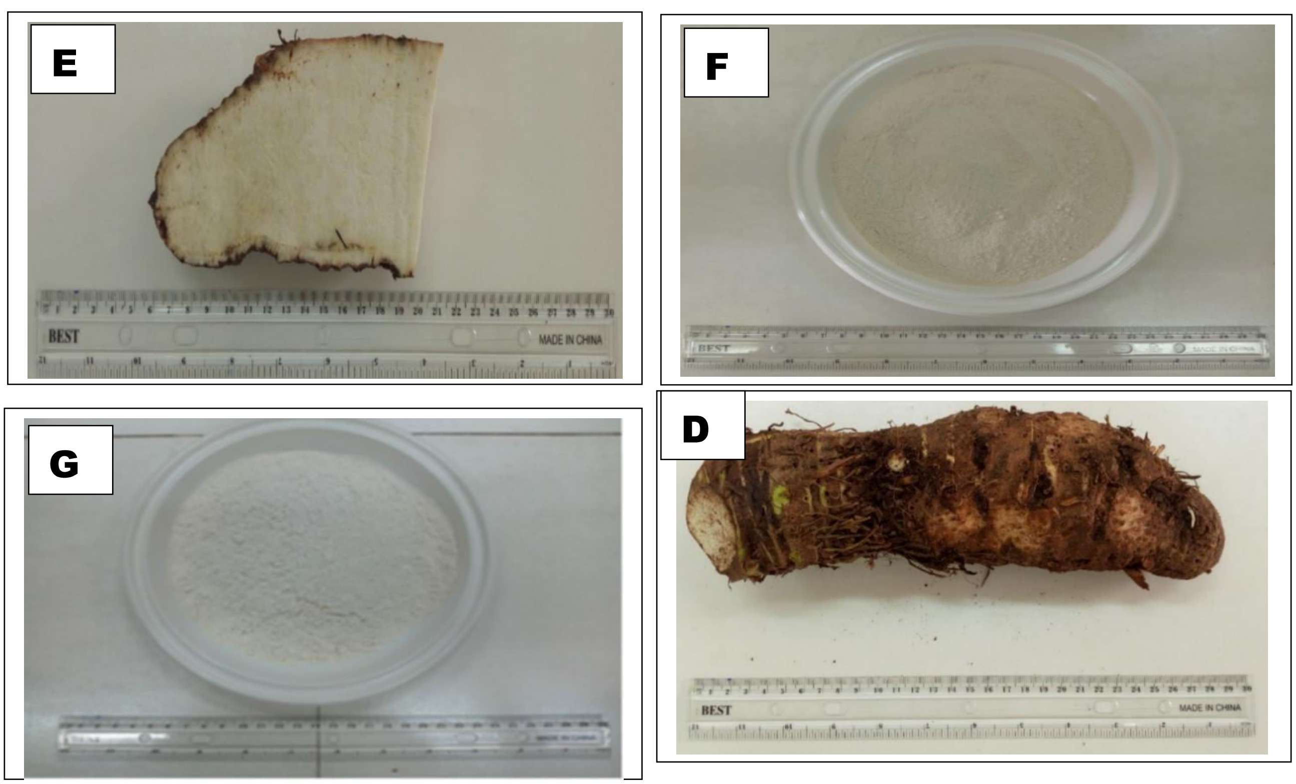
Ingredients	Control	Fouê formulations	Yatan formulations
T45 wheat flour (100% wheat)	200 g	0	0
Composite flour	0	200 g	200 g
Garlic	½ clove	½ clove	½ clove
Onion	1	1	1
Oil	1.5 L	1.5 L	1.5 L
Water	50 mL	50 mL	50 mL
Salt	1.5 g	1.5 g	1.5 g

Figure.1 Taro (*Colocasia esculenta*) corms and powder of the "Fouê" cultivar.



A: Whole corm; **B:** Longitudinal section of the corm; **C:** Taro powder, "Fouê" cultivar; **D:** Type 45 (T45) wheat flour.

Figure.2 Taro (*Colocasia esculenta*) corms and powder of the "Yatan" cultivar.



E: Whole corm; **F:** Longitudinal section of the corm; **G:** Taro powder, "Yatan" cultivar; **D:** Type 45 (T45) wheat flour.

Figure.3 Process for obtaining taro (Colocasia esculenta) corm powder.

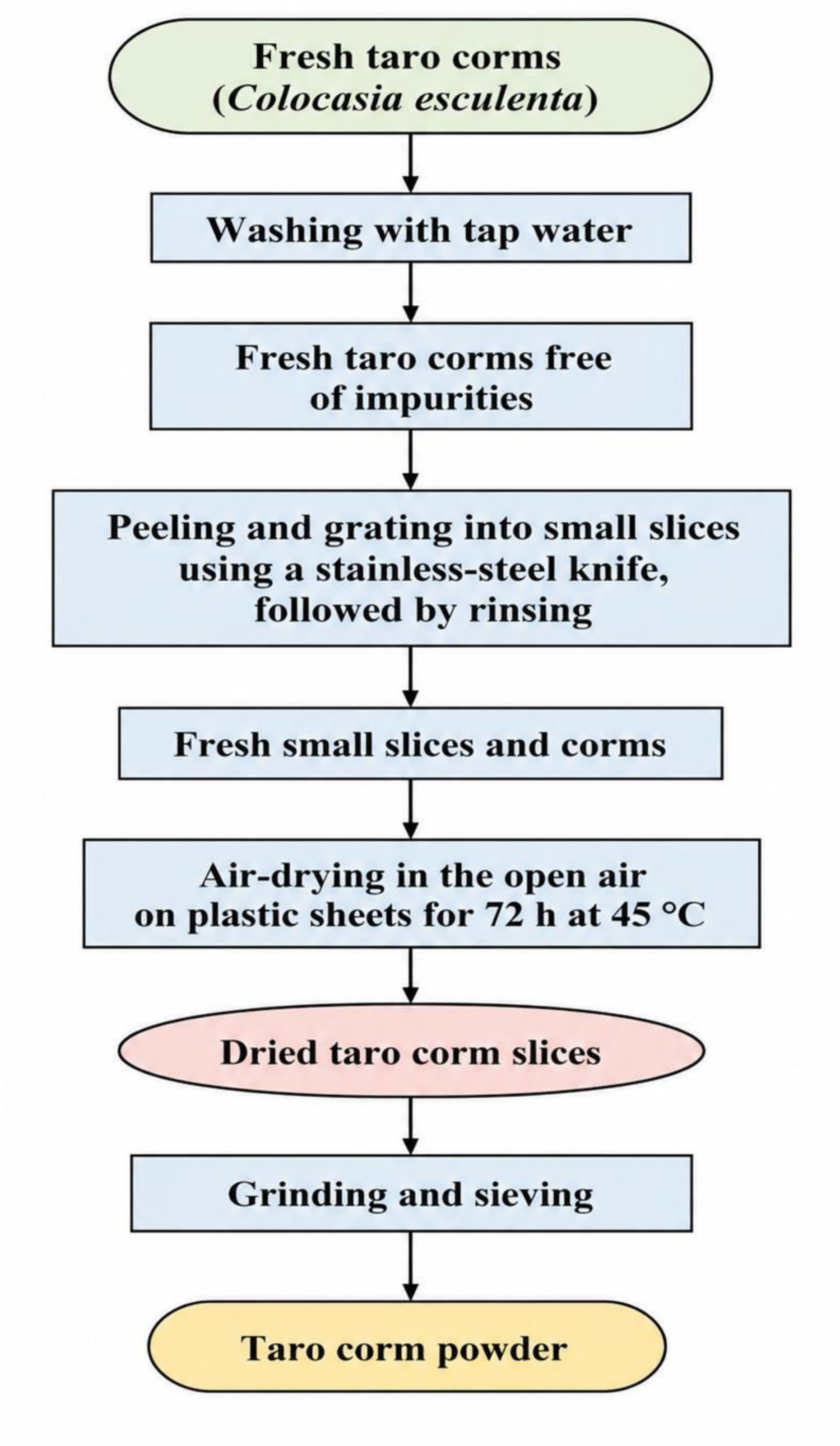


Figure.4 Nems preparation process.

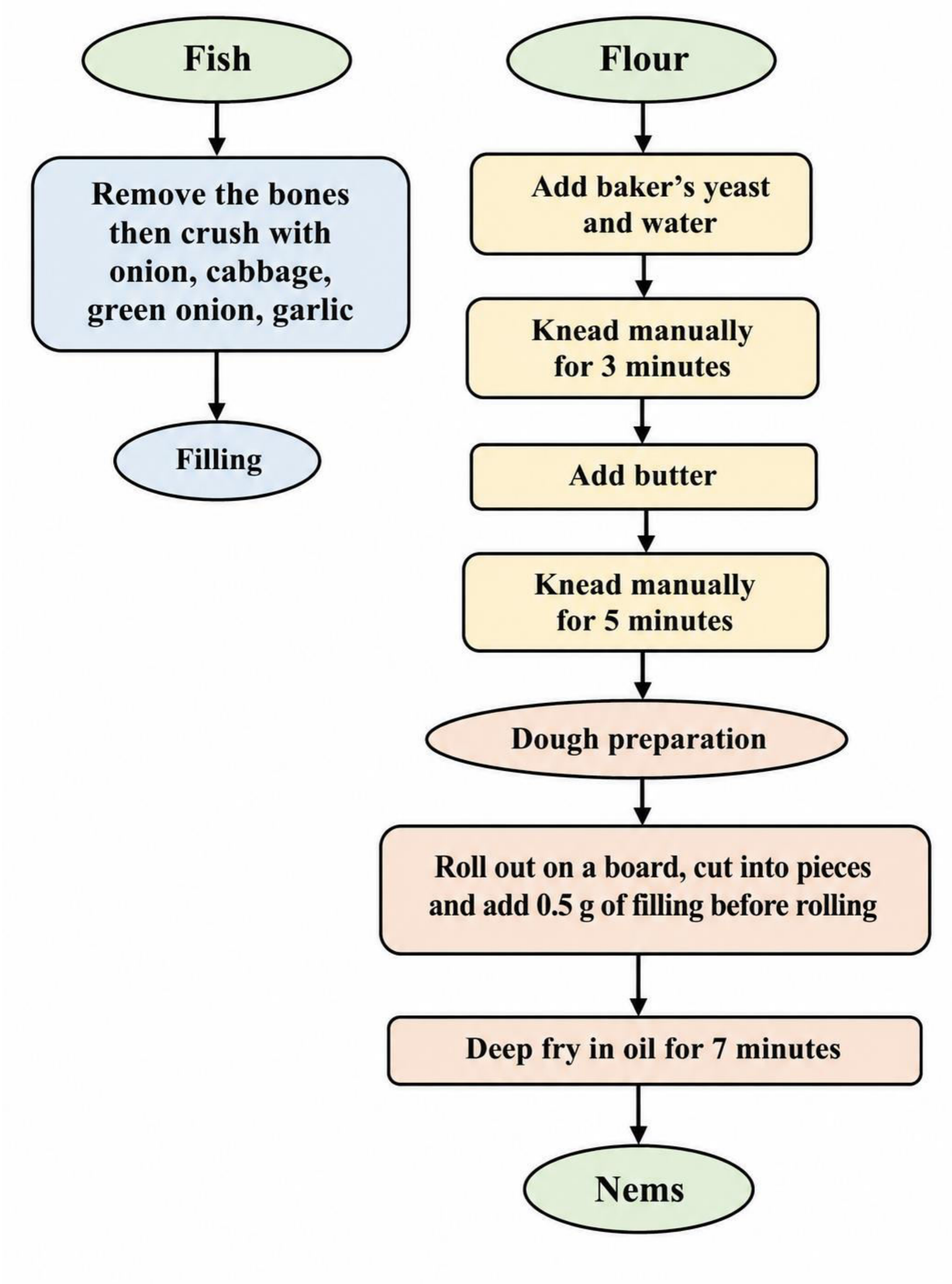


Figure.5 Snowball pastry preparation process.

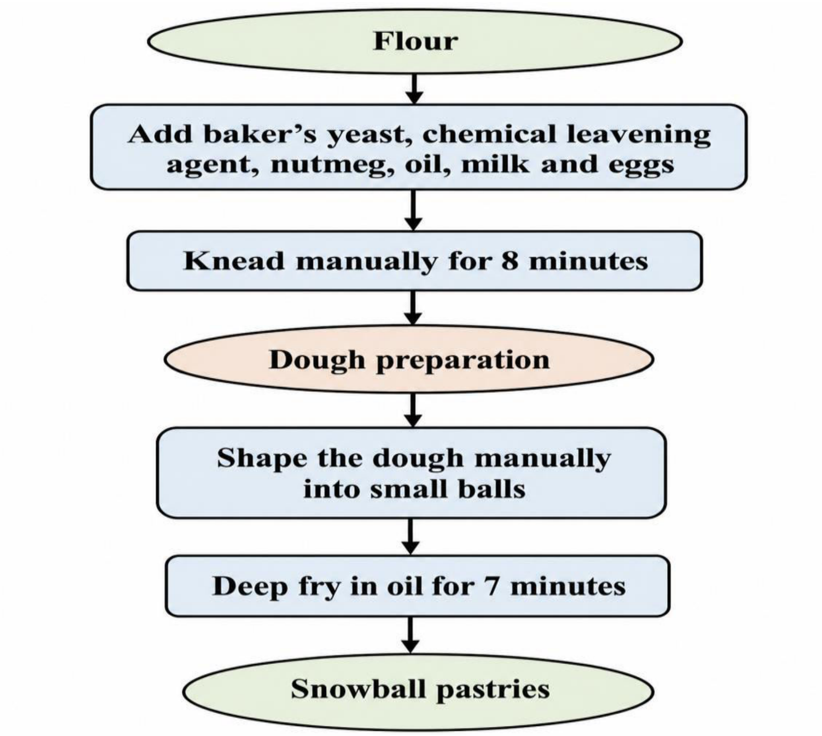


Figure.6 Savory croquette preparation process.

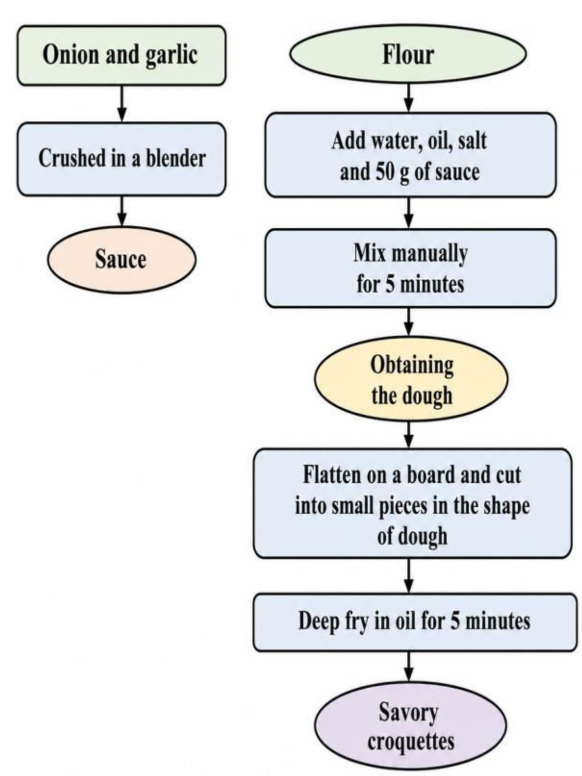
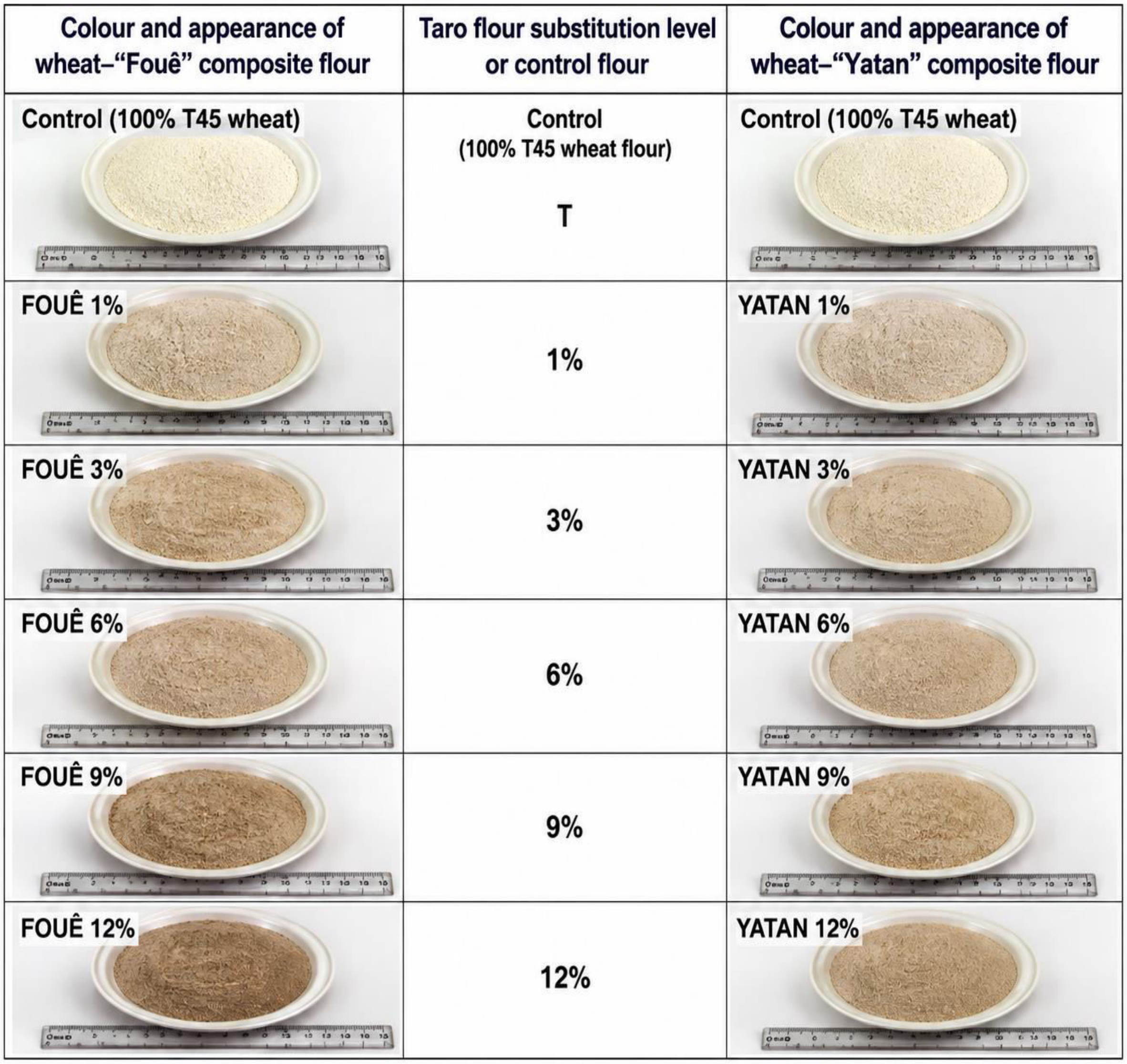


Figure.7 Colour an appearance of whteat-taro composite flours prepared with different substitution levels of taro corn powder from the "Foue" and "Yatan" cultivars.



A) Wheat-"Foue" composite flour B) Wheat-"Yatan" composite flour

Figure.8 Photographs of nems prepared using wheat–"Fouê" composite flour, wheat–"Yatan" composite flour, and the 100% T45 wheat flour control.

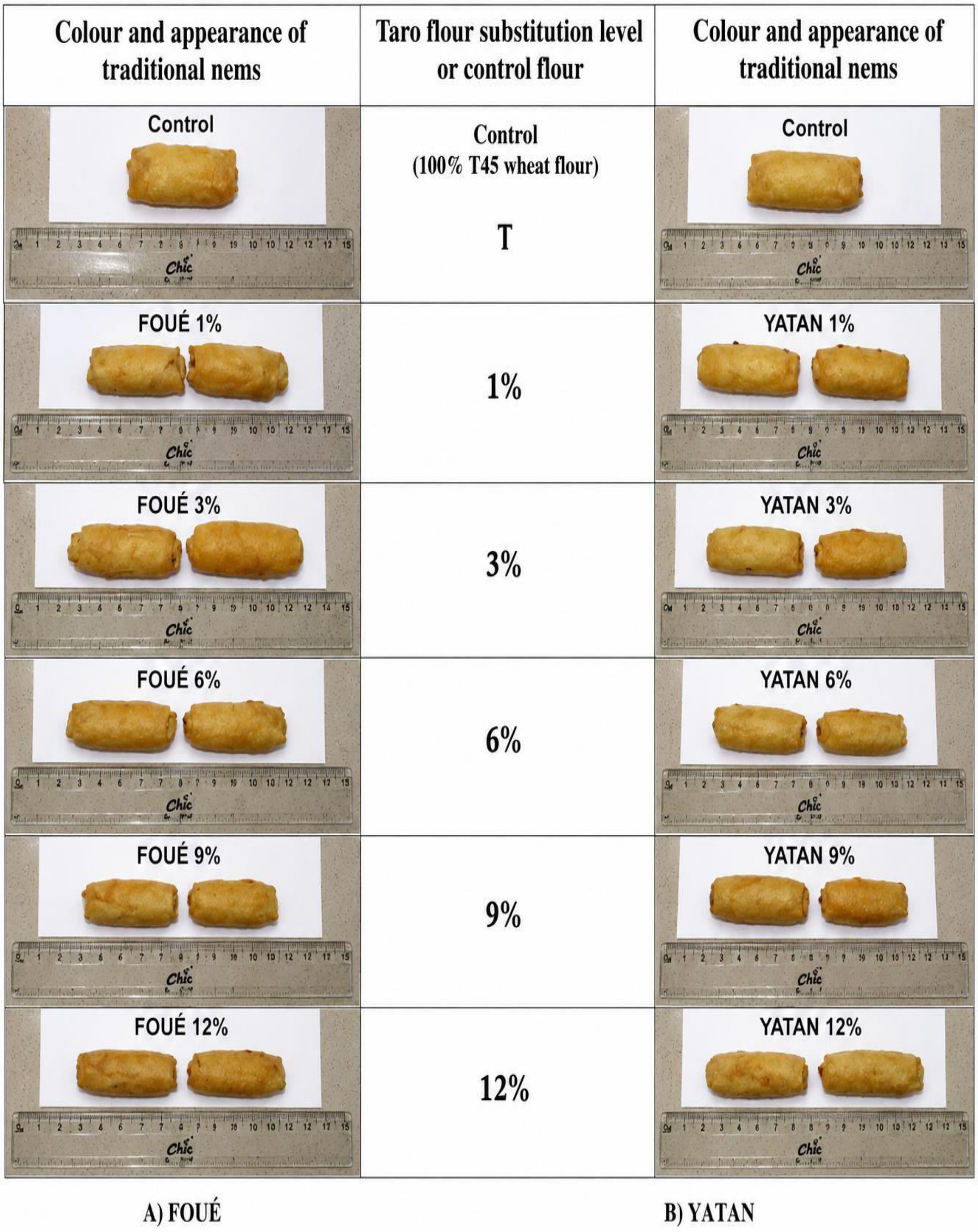


Figure.9 Photographs of snowball cookies made from composite wheat-fouê, wheat-yatan flours, and the control flour (100% wheat T45).

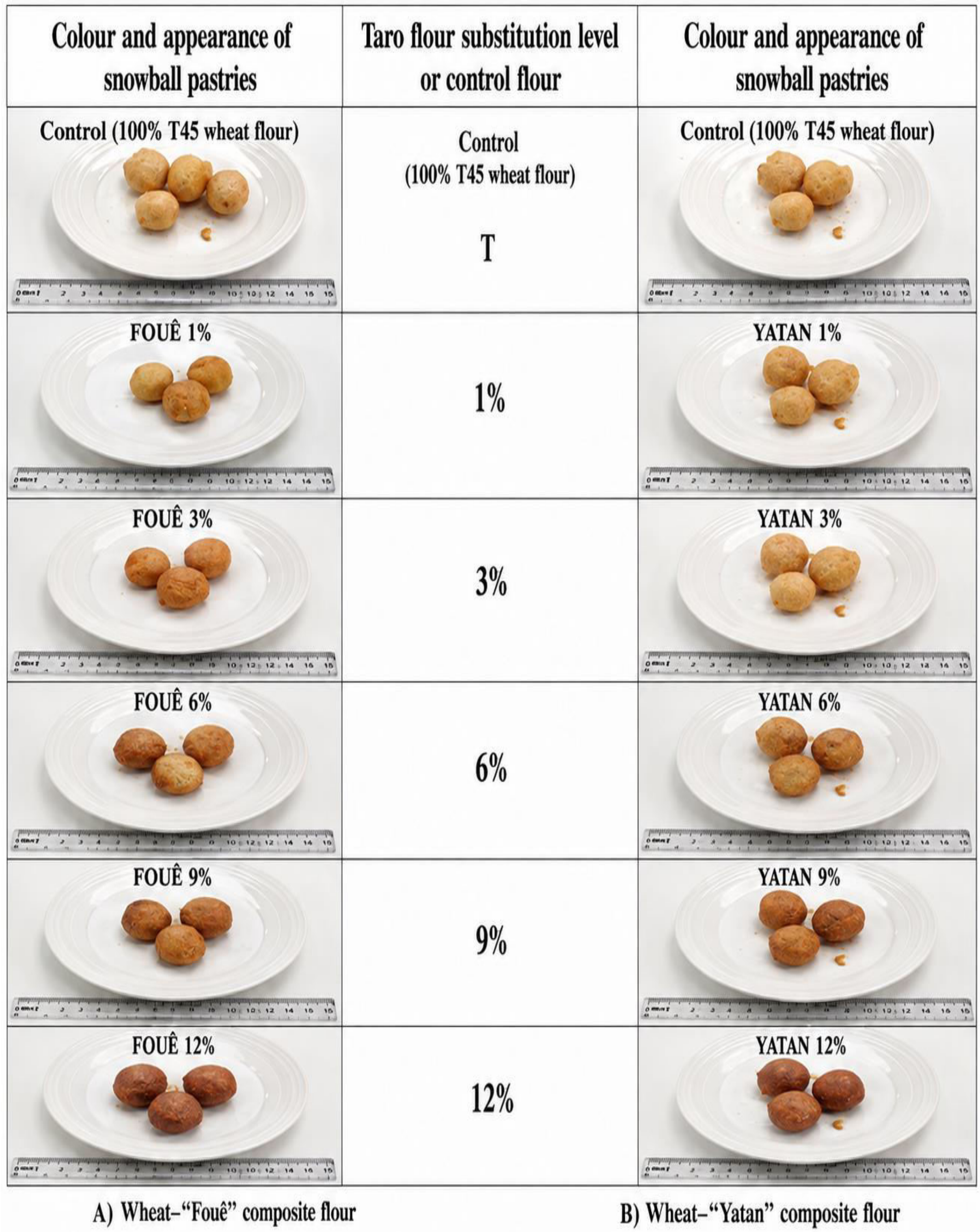


Figure.10 Photographs of savory croquettes made from composite wheat-fouê, wheat-yatan flours, and the control flour (100% wheat T45).

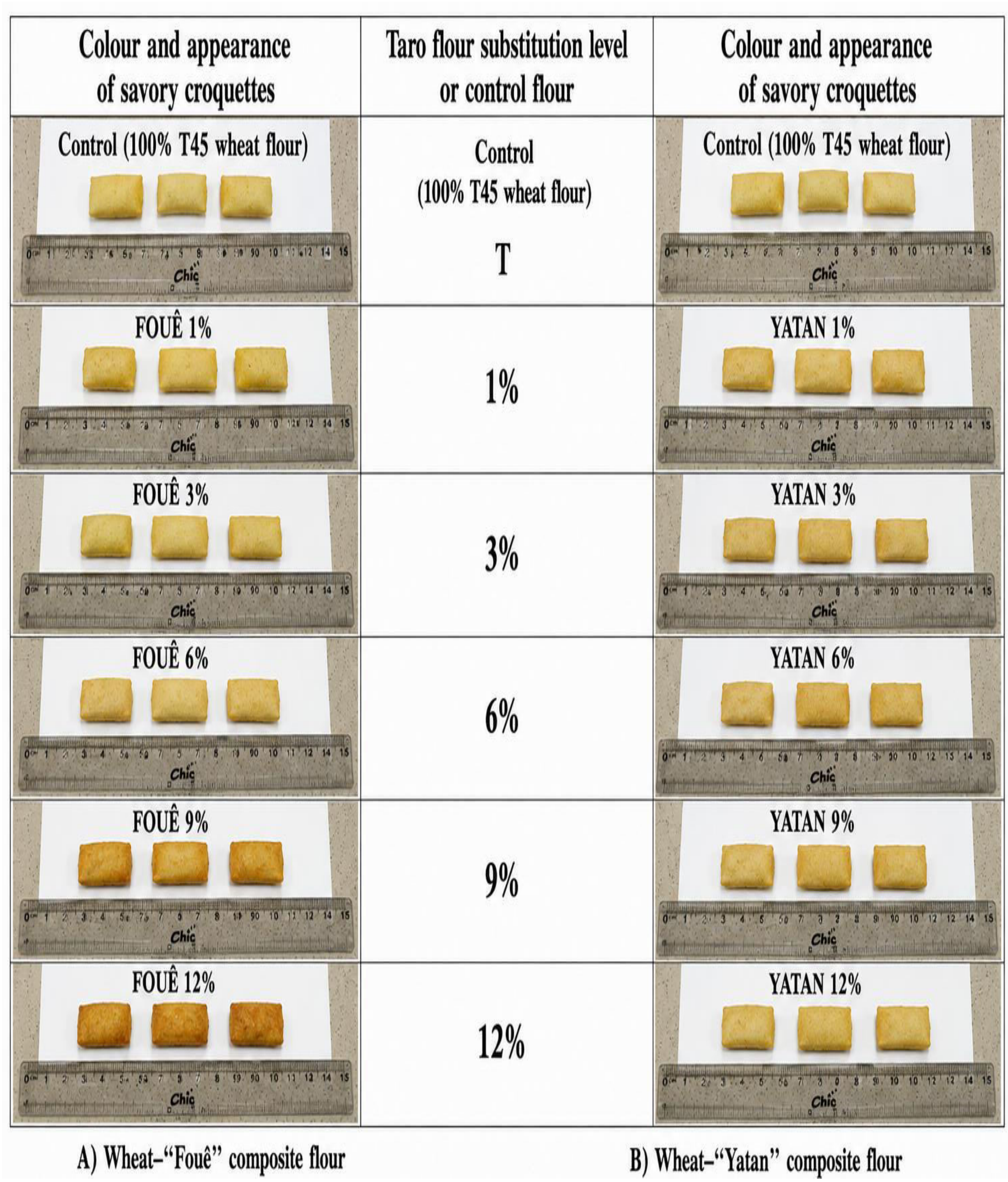


Figure.11 Organoleptic characteristics of traditional spring rolls made from composite wheat-fouê flour and the control flour (100% wheat T45).

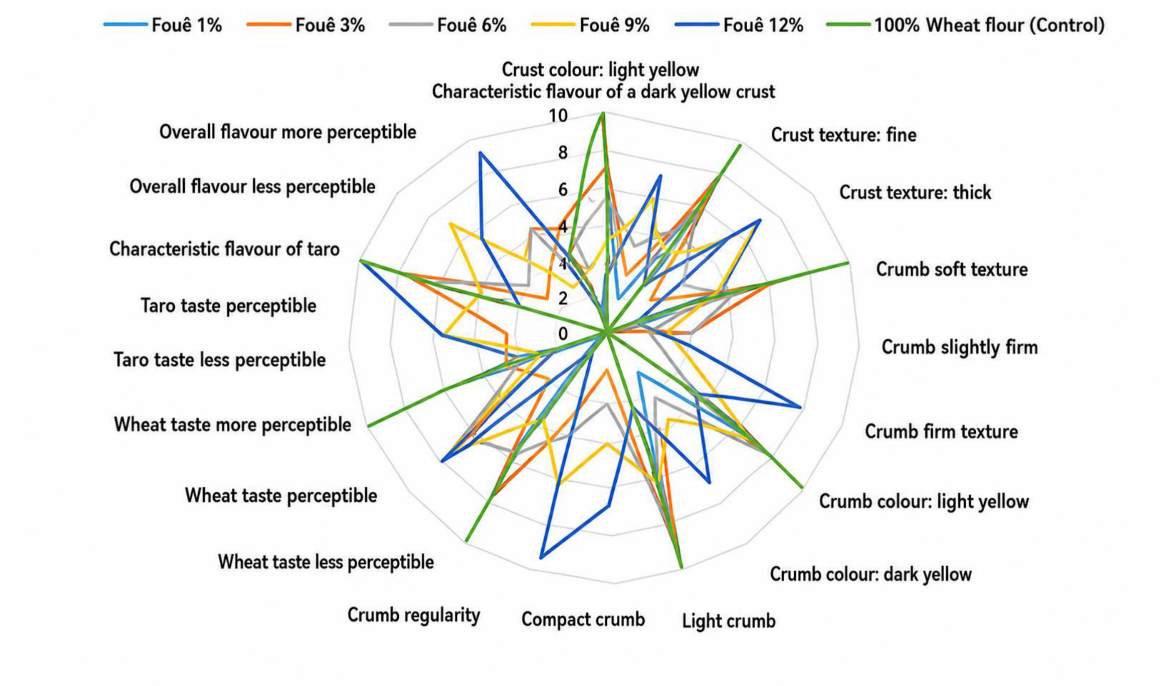


Figure.12 Organoleptic characteristics of traditional spring rolls made from composite wheat-yatan flour and the control flour (100% wheat T45).

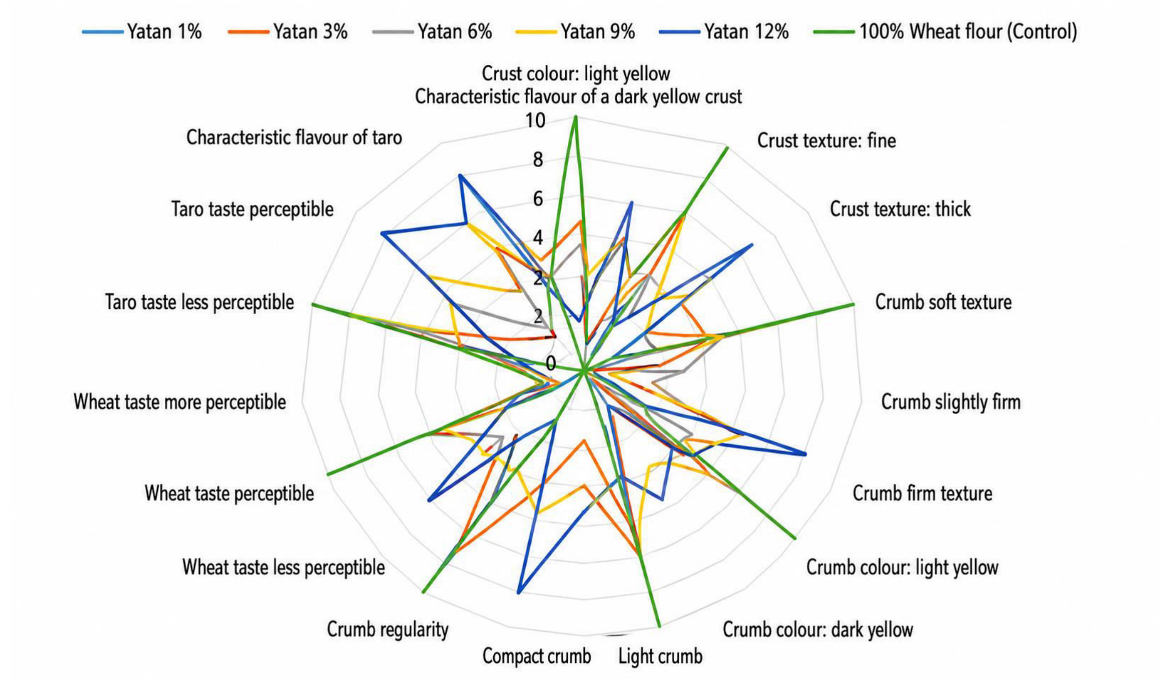


Figure.13 Organoleptic characteristics of snowball cookies made from composite wheat-fouê flour and the control flour (100% wheat T45).

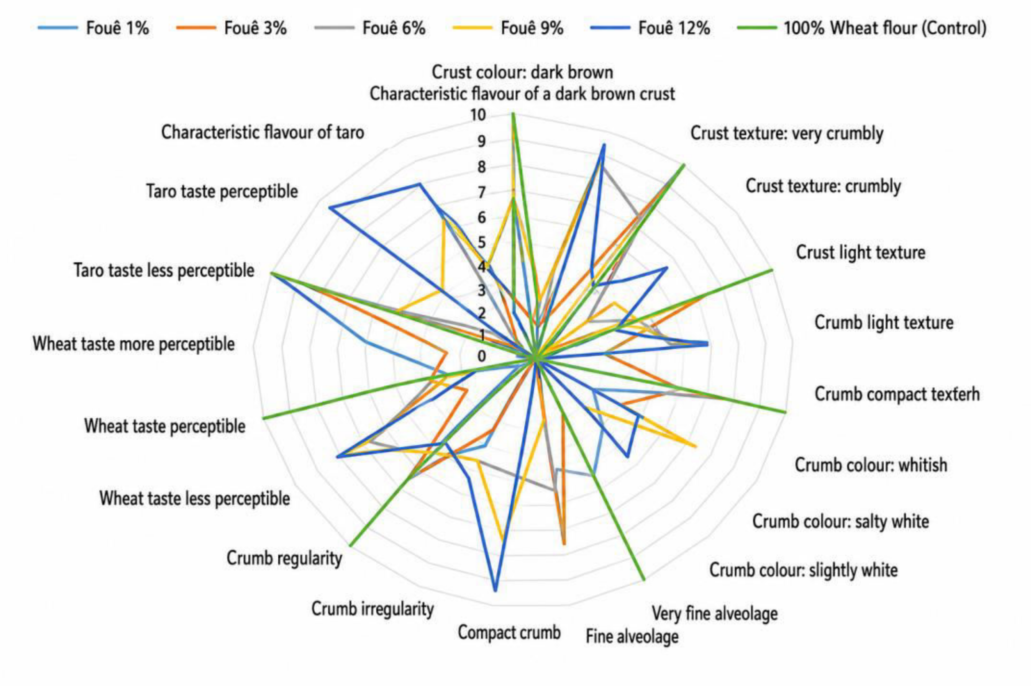


Figure.14 Organoleptic characteristics of snowball cookies made from composite wheat-yatan flour and the control flour (100% wheat T45).

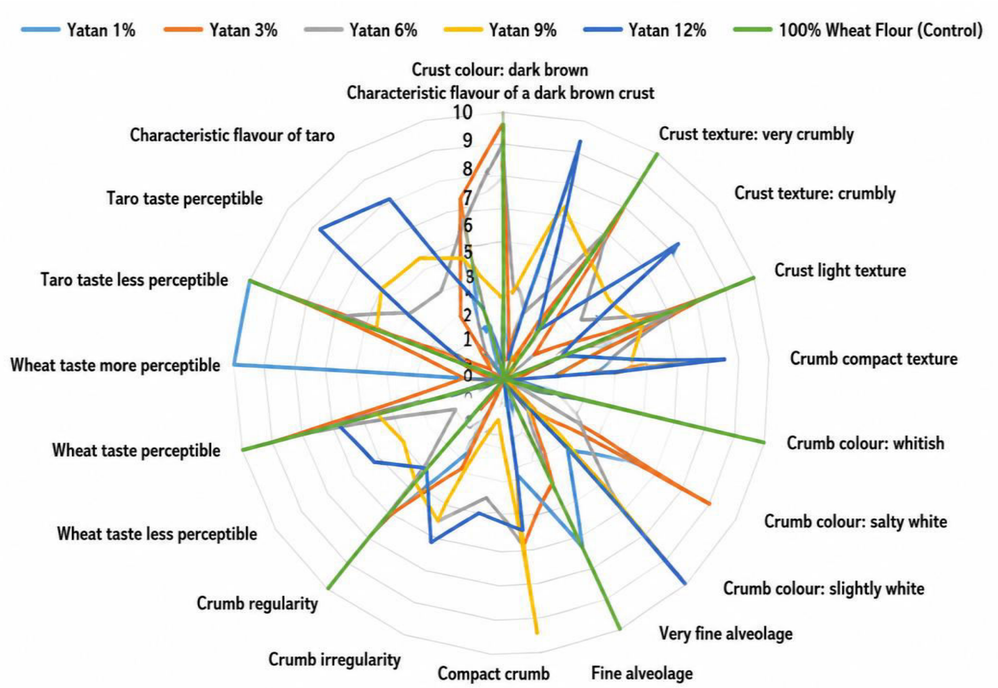


Figure.15 Organoleptic characteristics of savory croquettes made from composite wheat-fouê flour and the control flour (100% wheat T45).

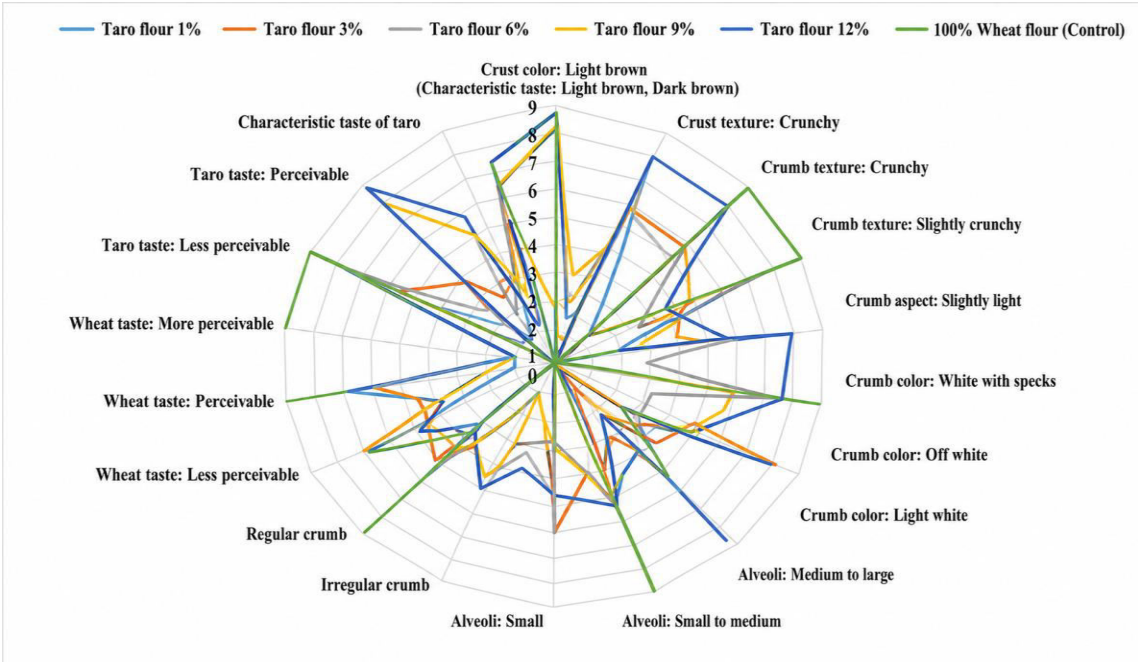


Figure.16 Organoleptic characteristics of savory croquettes made from composite wheat-yatan flour and the control flour (100% wheat T45).

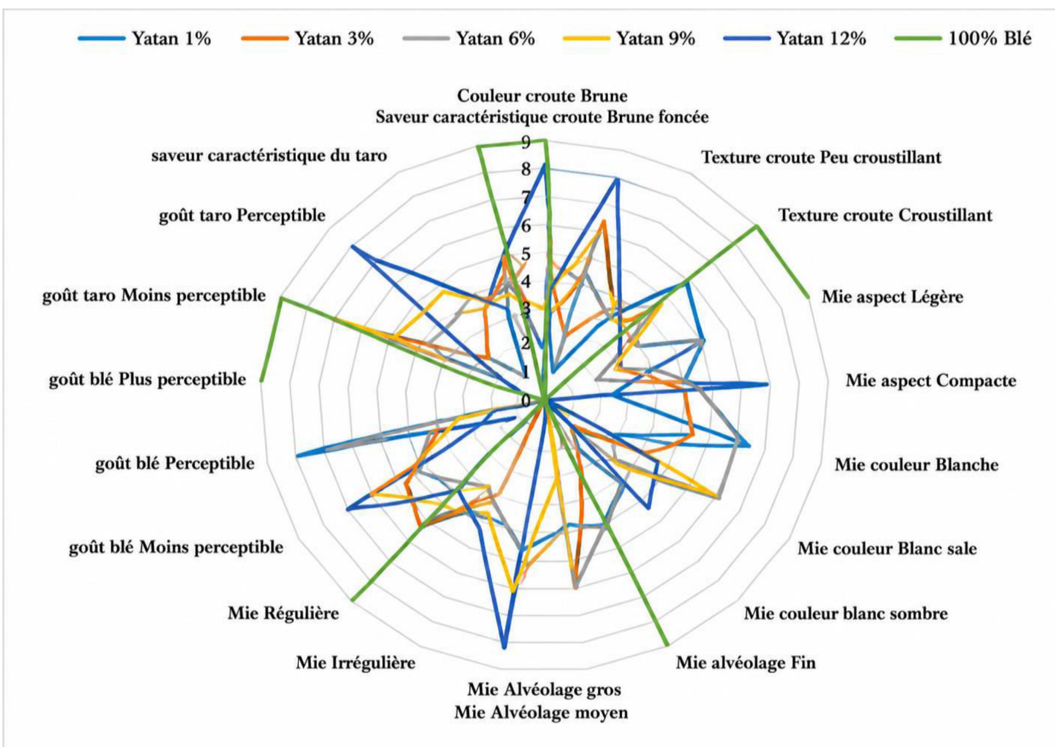


Figure.17 Overall acceptability of spring rolls made from composite wheat-fouê flour and the control flour (100% wheat T45).

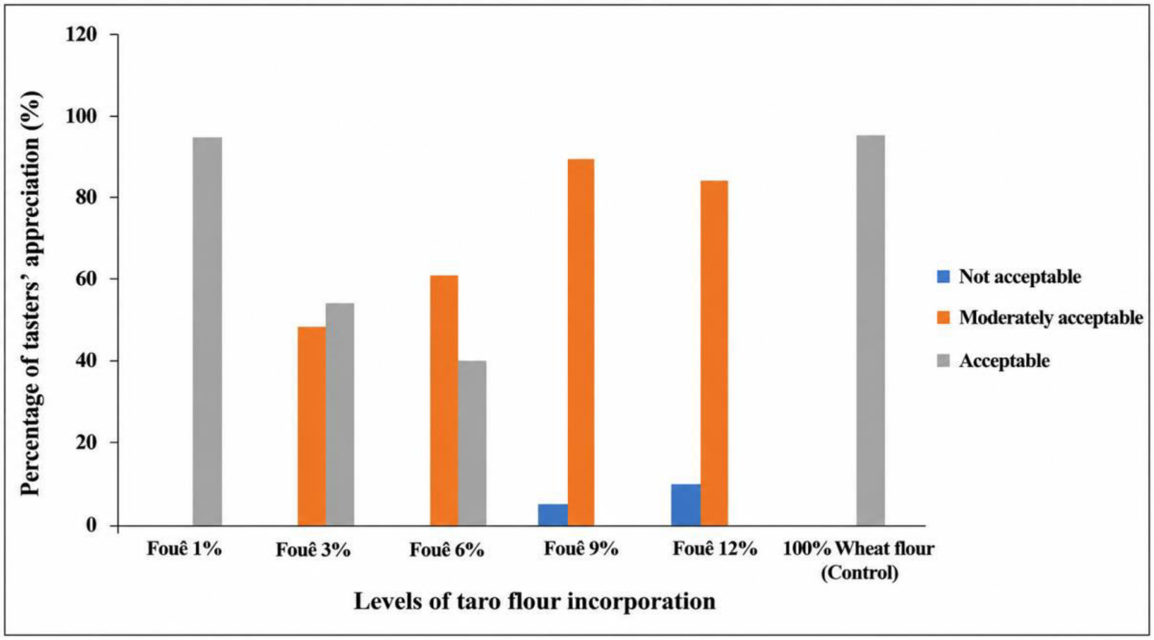


Figure.18 Overall acceptability of spring rolls made from composite wheat-yatan flour and the control flour (100% wheat T45).

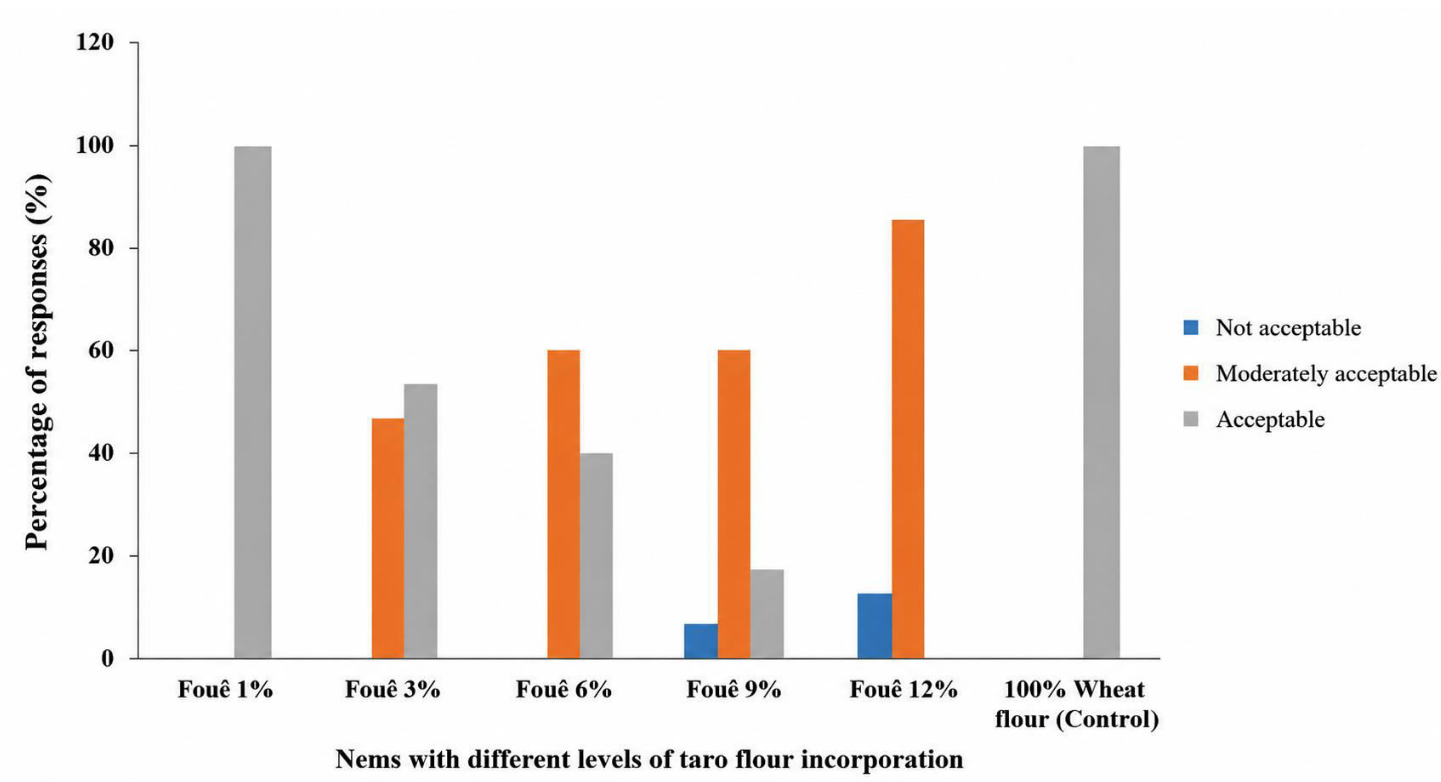


Figure.19 Overall acceptability of snowball cookies made from composite wheat-foué flour and the control flour (100% wheat T45).

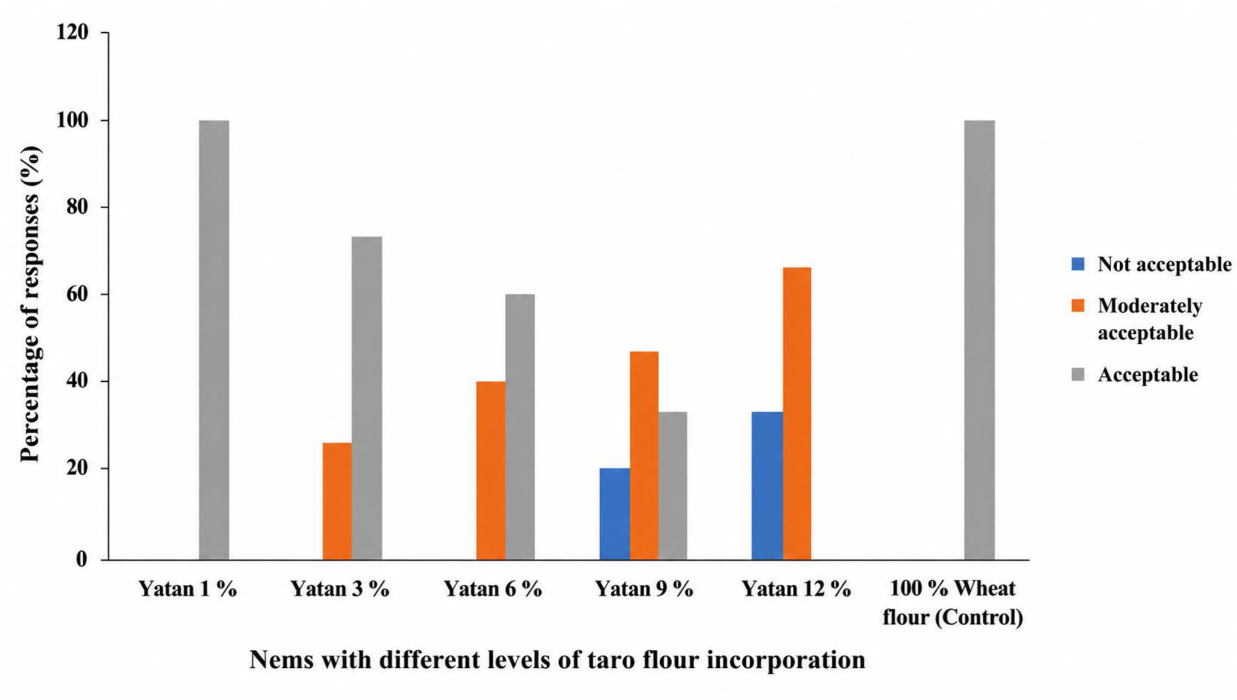


Figure.20 Overall acceptability of snowball cookies made from composite wheat-yatan flour and the control flour (100% wheat T45).

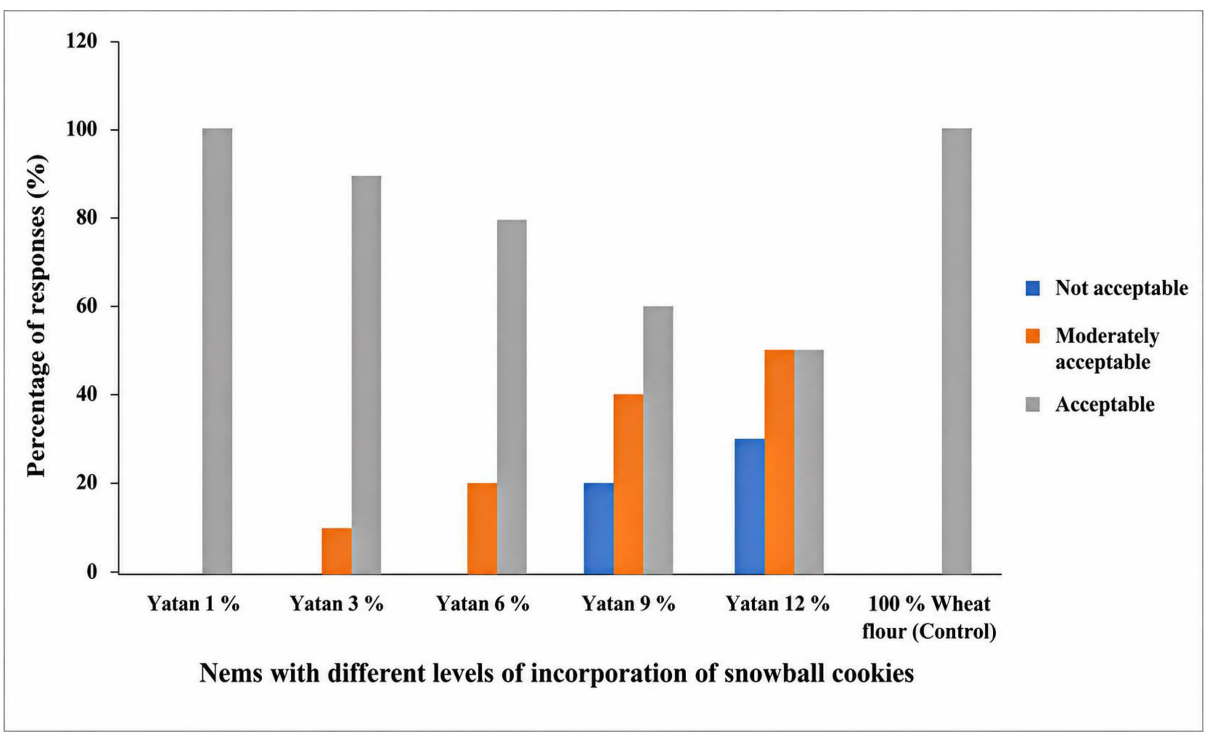


Figure.21 Overall acceptability of savory croquettes made from composite wheat-fouê flour and the control flour (100% wheat T45).

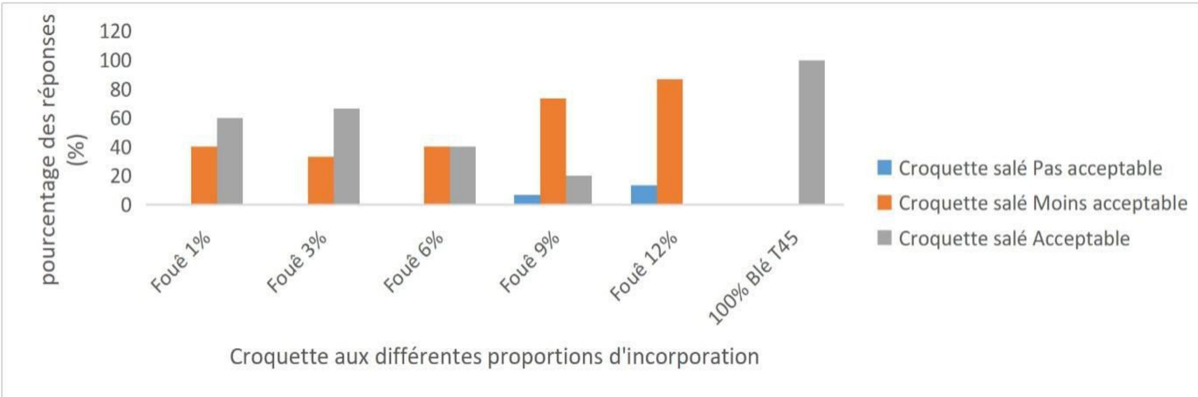
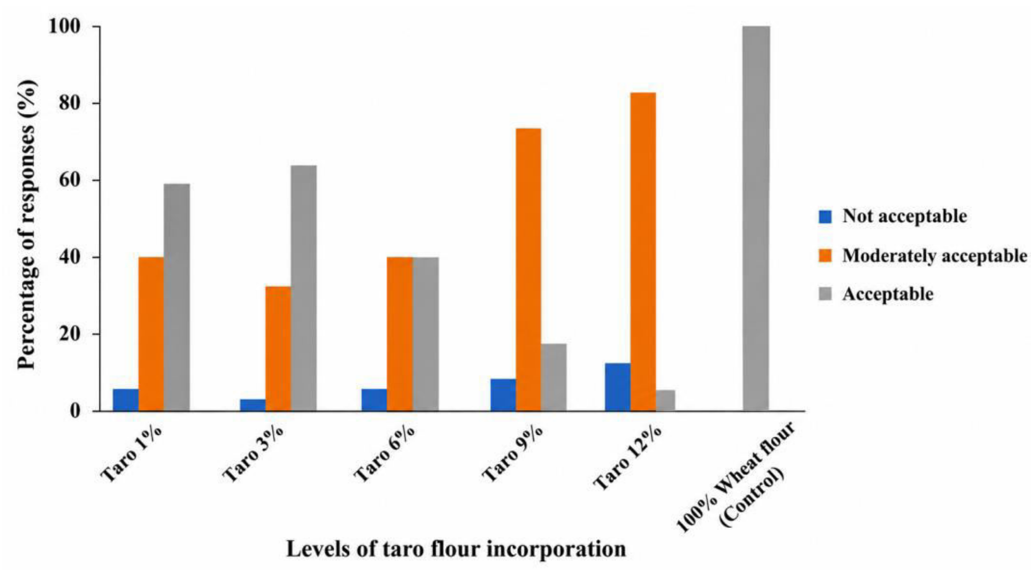


Figure.22 Overall acceptability of savory croquettes made from composite wheat-yatan flour and the control flour (100% wheat T45).



Acceptability of Snowballs Prepared with Wheat–"Fouê" and Wheat–"Yatan" Composite Flours

Overall acceptability was evaluated using a three-point scale (*unacceptable, less acceptable, and acceptable*) for the snowballs prepared with wheat–"Fouê" and wheat–"Yatan" composite flours (Figures 19 and 20).

Unlike the other two products, the snowballs were generally well appreciated and accepted by most of the panelists, even at a substitution level of 12%. However, the degree of acceptability gradually decreased as the incorporation level of taro powder from the "Fouê" and "Yatan" cultivars increased.

The acceptability rates of the snowballs prepared with wheat–"Fouê" and wheat–"Yatan" composite flours were very similar, with no significant difference observed between the two formulations.

Acceptability of Savory Croquettes Prepared with Wheat–"Fouê" and Wheat–"Yatan" Composite Flours

Overall acceptability was also evaluated using a three-point scale (*unacceptable, less acceptable, and* *acceptable*) for savory croquettes prepared with wheat–“Fouê” and wheat–“Yatan” composite flours (Figures 21 and 22). The savory croquettes were well appreciated and accepted up to a 6% substitution level. The acceptability rates of the croquettes prepared with wheat–“Yatan” composite flour at 1%, 3%, and 6% substitution were 80%, 70%, and 65%, respectively.

In contrast, the savory croquettes prepared with wheat–“Fouê” composite flour at 1%, 3%, and 6% substitution had acceptability rates of 60%, 65%, and 50%, respectively. Samples containing 9% and 12% taro powder were rejected by some of the panelists. The rejection rate was highest (30%) for the 12% wheat–“Yatan” formulation, whereas the rejection rate for the 12% wheat–“Fouê” formulation was approximately 15%.

Sensory quality is an important dimension of food quality and is perceived through the human senses, including sight, smell, taste, hearing, and touch (Meilgaard *et al.,* 1991b). The sensory results obtained in this study indicate that the taro cultivar had little influence on the overall organoleptic characteristics of the products prepared.

To establish the sensory identity of the different products, profiles were developed using several descriptors, including colour, aroma, taste, and texture. The scores obtained indicate that the products were generally well appreciated by the panelists. However, acceptability decreased progressively as the substitution level increased, particularly at 9% and 12%. This observation is consistent with the findings of Yao *et al.,* (2014) for cakes prepared from wheat–plantain composite flour.

The appearance and brightness of the products decreased as increasing quantities of wheat flour were replaced with taro powder, resulting in progressively darker colours. This reduction in brightness may be associated with the incorporation of *Colocasia esculenta* corm powder from the “Yatan” and “Fouê” cultivars into wheat flour, as well as with the storage period of the composite flours and the brightness characteristics of taro powder gel.

Regarding crust colour, Bello-Perez *et al.,* (2000) suggested that the colour of bread crust produced from wheat–taro composite flours may be related to the brownish-red colour of taro corm powder. This observation agrees with the findings of Mongi *et al.,* (2011), who also investigated wheat–taro composite flours. The darker crust colour observed at 9% and 12% substitution may be associated with the higher proportion of taro powder. Mongi *et al.,* (2011) further suggested that crust colour may result from the Maillard reaction between reducing sugars and amino acids. Raidi and Klein (1983) similarly reported that bread crust colour can change from creamy white to dull or dark brown. In the present study, the colour changed from light yellow to dark yellow or from white to darker white depending on the product, which may be attributed to the quantity of “Fouê” and “Yatan” taro powder incorporated into the wheat flour.

Other factors, including the chemical composition of taro and wheat, drying temperature and duration, and cooking temperature and time, may also influence crust colour (Ikpeme *et al.,* 2009).

With regard to the crumb, products containing 1%, 3%, and 6% taro powder generally received good scores, whereas products containing 9% and 12% received lower scores. This may be related to the higher proportion of taro flour, as reported by Dhighra and Jood (2004). Products prepared with 9% and 12% substitution exhibited a harder crust and crumb structure, and their appearance became less acceptable as the level of wheat flour substitution increased.

Furthermore, Salmenkallio-Marttila *et al.,* (2001) reported that dietary fibre can weaken bread structure by reducing crumb volume and elasticity. This effect has been attributed to interactions between fibre and gluten, resulting in reduced gas-retention capacity (Gomez *et al.,* 2003; Ishida and Stell, 2014). Crumb structure also depends on the behaviour of gas bubbles during processing. The present results are consistent with those of Dhighra and Jood (2004), who observed changes in crumb colour from creamy white to dull brown and a progressive increase in crumb hardness as the amount of soybean and barley flour increased.

Regarding crust texture, almost all the products exhibited a good crispy texture. Similarly, the crumb appearance was generally comparable among the products, except for those prepared with 9% and 12% composite flour.

Regarding crumb alveolation, products prepared with 1%, 3%, and 6% substitution exhibited alveolar structures similar to those of the 100% wheat control. Consequently, products prepared with 1%, 3%, and 6% substitution were the most appreciated by the panelists. These findings are similar to those reported by Mongi *et al.,* (2011) and Adeniji (2015).

The products prepared with 1%, 3%, and 6% composite flour also exhibited aroma and flavour characteristics close to those of the control products. This may be related to the relatively low proportion of taro flour incorporated into the formulations. Based on the present findings and in comparison with the results of Mongi *et al.,* (2011), partial substitution of wheat flour with taro powder at levels of up to 10% may be acceptable for the preparation of traditional products.

Overall, the panelists reported high acceptability for most sensory descriptors, except for products containing 9% and 12% substitution.

Thus, products prepared with 9% and 12% substitution exhibited sensory characteristics that differed substantially from both the control and products containing 1%, 3%, and 6% substitution.
Regarding overall acceptability, the sensory tests showed that the products prepared with taro–wheat composite flour generally achieved acceptable ratings. The taro cultivar, whether "Fouê" or "Yatan," did not have a major effect on overall acceptability. All snowball pastries were accepted by the panelists, whereas African nems and savory croquettes were accepted up to a 6% taro powder incorporation level. Above 6%, the products were not generally accepted by the panelists.

Overall acceptability was significantly influenced by the level of wheat flour substitution with taro flour. Acceptability was also associated with odour, colour, and texture, consistent with the findings of Aboubakar (2009).

The scores obtained indicate that products containing 100% wheat flour or substitution levels below 9% were accepted by the panel, whereas products at higher substitution levels were only moderately accepted.

This study was conducted to valorize taro corms from the "Fouê" and "Yatan" cultivars by investigating their potential application in the food-processing industry, particularly in the preparation of traditional pastry products. The results demonstrated that the substitution level influenced the organoleptic characteristics of the products evaluated.

Sensory analysis of the traditional products prepared with different proportions of wheat–taro composite flour generally showed high scores for the evaluated sensory descriptors.

Products containing 1%, 3%, and 6% wheat–taro composite flour from the "Fouê" and "Yatan" cultivars were the most preferred by the panelists. The organoleptic characteristics of products containing 1%, 3%, and 6% substitution were similar to those of the 100% wheat control.

These findings indicate that taro corm powders from *Colocasia esculenta* cultivars "Fouê" and "Yatan" can be incorporated at levels of up to 6% into wheat flour to produce acceptable traditional pastry products, including snowballs, nems, and savory croquettes.

Overall, the results demonstrate that "Fouê" and "Yatan" taro corm powders have potential as partial substitutes for wheat flour in the preparation of modern pastry products.

Future Perspectives

Future studies should:

1. Investigate the influence of variations in the physical processing parameters used in the production of traditional products on the organoleptic quality of wheat–taro composite products.
2. Develop viennoiserie products using the different composite flour formulations and evaluate their acceptability.
3. Determine the acceptability of wheat–taro composite flours using an untrained consumer-oriented sensory panel.

Author Contributions

Koman Florent ANON: Investigation, formal analysis, writing—original draft. Hyacinthe Attoh ANON: Validation, methodology, writing—reviewing. Martin Luthère King N'GBO:—Formal analysis, writing—review and editing.

William Kwithony DISSEKA: Investigation, writing—reviewing. Sana Étienne SILUÉ: Resources, investigation writing—reviewing. Patrice Lucien KOUAMÉ: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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