

Use of Vegetables as a New Ingredient in the Formulation of Cupcakes for New Trends and Eating Habits

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Day by day, there is a growing trend and interest in introducing new ingredients and elements to create food to guarantee or achieve food safety and good health. With these creations, it is tried that the new foods satisfy needs at a nutritional level, mainly because of the benefits that they can offer for specific health conditions that some individuals of the population present, such as diabetes, coronary heart disease, and some cancers, among others. On the other hand, it is also tried with these new foods that can help to supply dietary preferences that, in one way or another, are associated with all those changes in consumption habits in communities. Changes are given by factors such as obesity or aging, and that in the end, changes are associated with needs, acquired behaviours, or people's conditions. Among the versatile products for incorporating new ingredients and generating new formulas are from the bakery activity. It is common on these products to find that vegan Cupcakes are offered (those that are made with only fruits and without any derived from animals such as milk or eggs) and sweet Cupcakes (made with sugar). In this work, the introduction of vegetarian and vegan cupcakes, made from ingredients such as spinach, carrots, tomatoes, corn, and mushrooms, is presented as an innovation. These cupcakes are characterized by low carbohydrate content and are ideal for maintaining low-fat, low-carb diets. During the work, preferences of a segment of the population between 25-40 years old are evaluated, who have health problems related to diabetes, and consider the cupcake proposal attractive. Additionally, characteristics of the formulated and developed product are presented.

1. Introduction

At the level of the Latin American countries, Colombia occupies third place in population size. Due to the number of inhabitants, it faces realities where food insecurity plays a relevant role. Many people do not have access to quality food, and sometimes it is associated with the lack of access to nutritious food due to economic or provision problems. All this, in the end, represents poor quality in the diet and bad eating habits that affect the level of nutrition, health, and well-being. (FAO, 2020).

Regarding health problems, in the country, according to reports from the Ministry of Health and Social Protection, 3 % of inhabitants have diabetes mellitus. On the other hand, obesity and being overweight represent a significant concern worldwide. In Colombia, it is reported that 22.3 % and 58.9 % of people over 18 years of age suffer from obesity and overweight, respectively (FAO 2020). If we consider diabetes, it is presented in two types: type 1 is diabetes that occurs in the population under 30 years (children, adolescents, or young adults), and type 2 occurs in adults over 30 years (Abu Bakar et al, 2020). In both cases, the specialists affirm that among the factors contributing to disease generation are the poor diet that some people have and low-calorie burn due to lack of exercise.

According to the World Health Organization (WHO), the main reasons that generate obesity are poor eating habits and work routines that hinder or prevent physical activity (WHO, 2020). Likewise, some studies have highlighted the benefits of the intake of fruits, vegetables, nuts, and whole grains. These are rich in various essential nutrients (vegetable proteins, potassium, magnesium, vitamin C, phosphate, and other bioactive components) and possess antioxidant and anti-inflammatory capabilities (Kadkhoda et al., 2020).

Based on the above, people of all generations are concerned with having a good diet without neglecting small tastes for delicious foods. Since currently, there are also scenarios with lower quality diets, and this is directly related to issues such as for overweight and food insecurity. Given that the need arises to ensure that food meets the minimum calories and is of quality, interest is generated in developing new food products. These new products must be characterized by meeting nutritional requirements, being low in sugars, fats, and salt, contributing to leading a healthy and active life, and avoiding all forms of malnutrition. In principle, this would ensure a healthy life, and it could help reduce morbidity and mortality from diseases associated with eating. In addition, it is necessary to promote the health of children and adolescents by promoting healthy eating and discouraging the consumption and production of products with high levels of sugar, fat, and salt. Based on the above, this work introduces vegetarian and vegan cupcakes as an innovative food product made from ingredients such as spinach, carrots, tomatoes, ears of corn, and mushrooms.

2. Material and methods

The work was carried out in a company located in Bogotá, whose main activity is directed towards the development of vegetarian products, particularly the pastries known as cupcakes. The study is based on the adaptation of the approach to the new product development process (NPD), which various authors expose (Kelly et al., 2008; Pinna et al., 2018). In this approach, the food product development is defined, the structure is observed in Figure 1.

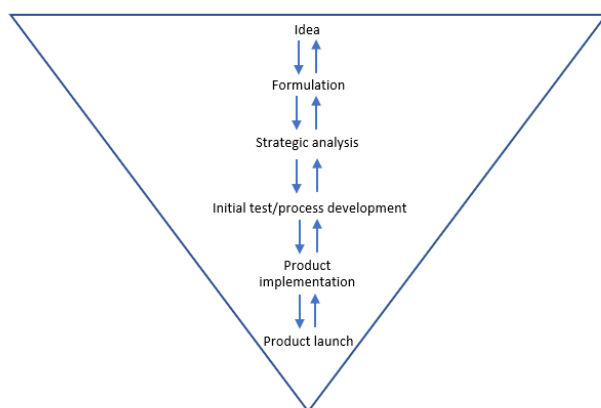


Figure 1: Representative pyramid for the NPD

Considering what is presented in Figure 1, the stages of NPD used during the study are defined as follows:

- **Idea:** it is the starting point where the functional and performance requirements of the food product are defined. They arise from needs identified in the market (consumer requirements, other markets).
- **Formulation:** the development of the product is carried out from the pre-existing knowledge of the product, the formulation, design and/or detailed and exhaustive requirements are selected for the processing of the product, it is taken into account which is what best suits the requirements of the user and/or consumer.
- **Business analysis:** at this stage, it is essential to convert the chosen raw materials and ingredients; the business objectives must be clear, it must be a safe product for consumption, maintain properties to have more acceptance and just as the functional or nutritional properties thereof must be preserved.
- **Initial testing and process development:** generally, the process is developed parallel to the initial tests from which prototype products emerge, which must be subjected to selection criteria to determine their suitability for production or returned to previous stages of the NPD strategy to intervene the product. It is evaluated that the product meets the requirements set by the manufacturer and the customer's needs.
- **Product implementation:** in this stage, it is validated that the product is by the client's needs, identified in the idea stage, the useful life of the product is determined, factors that intervene in safety and storage characteristics are identified for conservation of the product.
- **Launch:** the development of a new product needs to design a suitable packaging for distribution and sale, which contains, conserves, and protects it.

3. Results and discussions

3.1 Idea Stage

The first of NPD's strategies is the idea stage. In the vegetable-based product, it belongs to a company dedicated to the manufacture of vegetarian food focused on "Cupcakes." This idea is started by entrepreneurs who have an innovative business vision and want to enter the market with sustainable products that contribute to the economic, social, and environmental objectives proposed in the company's mission. For this purpose, the company creates a natural cupcake with ingredients rich in vitamins, low in sugar, and carbohydrates, providing benefits to people with diabetes and general to all types of consumers. People are empowered to consume a product that is tasty and healthy at the same time. Likewise, during the idea, the product was addressed to all those who are interested in consuming a product with low sugar and carbohydrate content, people with the first degree of treatable diabetes, vegetarians who are looking for a product without any ingredient of animal origin such as meat, this target audience can be seen in Table 1.

Table 1: Target audience

Types of people	Ages
People with type 2 diabetes "	25-40
Vegetarians (without any segmentation)	25-40

For the development of new food products, three perspectives are used to evaluate and drive innovation (technology perspective, market-oriented approach, and consumer-led product development, all to increase the success of the product (Earle, 1997) (van Boekel & Linnemann, 2007). With the encouragement of directing the new product to the third perspective, a survey was carried out where it inquired about the inclusion of a new product, starting from a sample of 56 people, where 75 % of the participants are between 25 and 40 years old, the results are recorded in Table 2. The level of intention to consume the vegetarian product is highlighted.

Table 2: Consumer perspective survey

Question	Yes (%)	No (%)	Do not know (%)
Do you know what diabetes is?	75	3.6	21.4
Are you a diabetic person?	94.5	3.6	2
Do you know someone with diabetes?	51.8	48.2	0
Is that person vegetarian?	1.8	98.2	0
Do you know a vegetarian person?	60.7	39.3	0
Do you consider that you eat healthy food?	37.5	55.4	7.1
Do you eat vegetables?	82.1	17.9	0
Have you tried vegetarian food?	57.1	42.9	0
Have you had vegetarian cupcakes?	19.6	80.4	0
Would you consume vegetarian cupcakes for: Health, Curiosity, taste or diet?	62.5	30.4	7.1
Do you know a place where vegetarian cupcakes are sold?	14.3	85.7	0

3.2 Formulation stage

Cupcakes are small cakes made from vegetables, such as spinach, carrots, broccoli, cornmeal, yeast, bicarbonate, and cinnamon. Combining these ingredients generates the cake with a soft and fluffy texture with nutritional characteristics and gluten-free. The cupcakes come in different sizes, 4-6 cm, and 2.5 cm. For the company's design, the 8 cm size was chosen, as shown in Figure 2, which allows 24 cupcakes to be manufactured in a mold, making batch manufacturing efficient.



Figure 2: Vegetable cupcake

3.3 Stage development of the process and initial test

The production analysis is essential to satisfy the market demand, with which it is possible to determine the volume of processing, storage, or production in the company. The determination of theoretical capacity, installed capacity, and real production was carried out, starting from the information from a study of methods and times previously carried out (not included in this document). For this, the following factors are established to consider:

- Time available per day = Shift from 7:00 am to 5:30 pm (1 hour of lunch and 30 min of rest) 9 working hours
- Production line efficiency = 90 %
- Working days = 5

Based on the above, Table 3 presents the analysis to produce cupcakes

Table 3: Production Analysis

	Months per year	Days month	perWorking hours	Pieces per hour	finished Pieces per year
Theoretical capacity	12	30	24	144	1244160
Installed capacity	12	twenty	24	144.2	311040
Actual production	12	twenty	9	144	311040

It is essential to mention in a working day time was taken to know how much the process is framed and this is 432 minutes, which includes from the preparation of raw material to the delivery of the product. The production cycle can be seen in Figure 3.

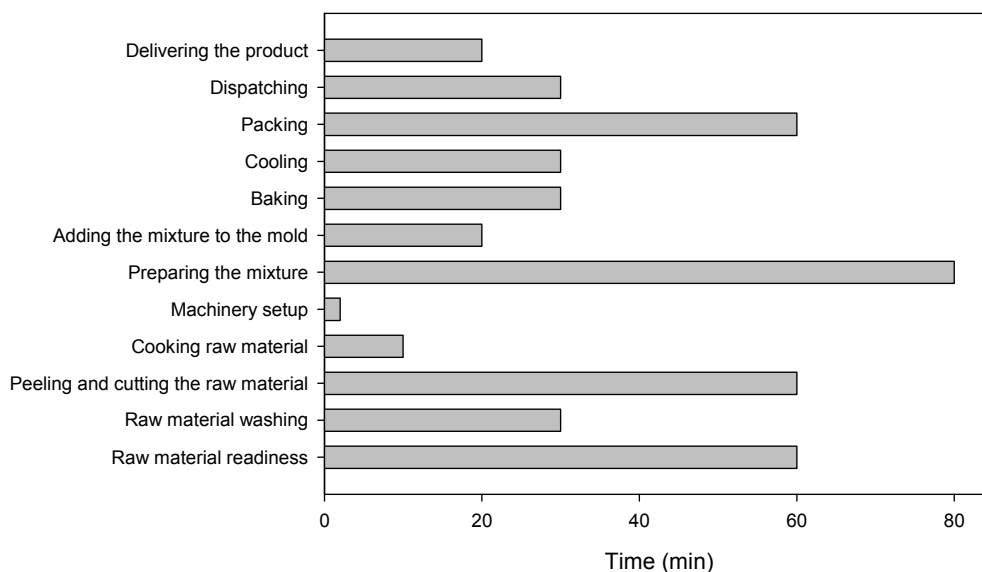


Figure 3: Production cycle times

A representation of the development of the entire process, including administrative tasks, can be seen through a flow diagram that can be seen in Figure 4.

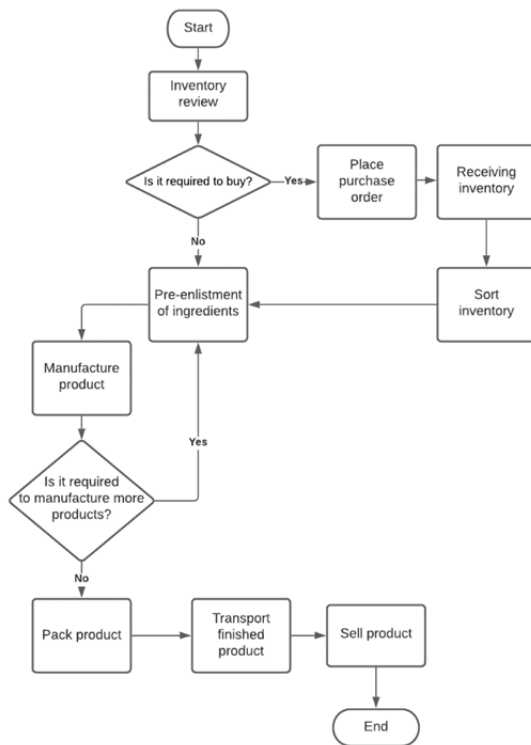


Figure 4: Process flow diagram

3.4 Product implementation

The products manufactured in the company for customers and consumers comply with current health and legal regulations. The product's useful life can be kept for a maximum of 4 days if it is refrigerated or kept at temperatures below 10 °C. This information is displayed on the product label to guide the consumer regarding product quality and safety. On the other hand, if the product is stored refrigerated for more than 4 days, it progressively loses its quality, especially its spongy texture.

3.5 Launch, Packaging, and labelling

Defining a container or container that preserves the product's properties and protects it from any external agent that may contaminate the product is of vital importance. It must also be guaranteed that the product meets the customer's expectations. During the proposal of the cupcakes, primary packaging is chosen that is observed in Figure 5a and secondary packaging, which not only fulfils the function of protecting but can also visually impact the consumer, the packaging is observed in Figure 5b. These packages are purchased in bulk and are Darnel® brand.



Figure 5a: Primary packaging



Figure 5b: Secondary package

On the other hand, within the information that will accompany the product, the nutritional information that will appear in it is considered. In Table 4 these values are found.

Table 4: Nutrition facts

Nutrition facts	Per 100g	%per portion
Total Fat	0.1	0.1
Saturated fat	0	1
Cholesterol	0.0	0
Sodium	2.1	1
Carbohydrate		3.3
Protein	50	2.5
Vitamin D	3.5	1.3
Calcium	1.5	1.2
Calories	35	35
Energy	505 kcal	8
	2113 kJ	

Finally, it is essential to mention that a financial study of the product was made. It is not included in this document, as it is sensitive information for the company.

4. Conclusions

The product developed from vegetables has acceptable physical characteristics and nutritional properties within the standards required by the authorities. It confirms the potential use of vegetables such as spinach, carrots, tomatoes, broccoli, and corn on the cob as a novel ingredient in low-carb, gluten-free cupcakes. Future studies will be necessary to take full advantage of the functionality of other gluten-free vegetables and cereals in the development of nutritionally balanced and tasty bakery products.

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