
ECOTROPHELIA DOSSIER

SPOON EAT

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1. Product description

Spoon-eat are exactly what the name implies. Spoons you eat. They're made primarily of chickpea flour mixed with rice flour, chestnut flour and cinnamon. Our innovation comes through the ingredients we use, Spoon-eat uses only Portuguese products, and our chestnut flour is a direct byproduct of frozen chestnut production, thus supporting a circular economy and striving to have a both environmentally sustainable, flavorful and nutritionally rich product, also due to the use of psyllium husk in its formulation, Spoon-eat is very rich in fiber. Spoon-eat's innovation doesn't stop at its ingredients, as such, this product is made using 3D printing technology, with it we can create different textures and new ways of experiencing food, following the trends.

We went through over 30 formulations before arriving at the present one.

With a relatively simple formulation they are comprised of chickpea flour, chestnut flour, rice flour, cinnamon, water, olive oil, white sugar, salt, psyllium husk and hpmc. These last two ingredients are the key to achieving Spoon-eat's texture and make it possible for the dough to be 3d printable. We start by grinding all the dry ingredients, so they match in size and don't block the printer's cartridges, these are then mixed with water and olive oil, it is also important to add that psyllium needs to be activated prior to its addition to the dough, forming a gel. After the spoons are printed, they go in the oven for 12 minutes at 180°C and then they are dehydrated at 60°C for about 2 hours and after being cooled off they're ready!

Spoon-eat's product is labeled as being a source of protein, having high content of fiber and is also vegan, gluten free, kosher and halal. These are a fun and tasty way to spoon whatever you want, it's environmentally sustainable and innovative. Spoon-eat are the spoon-shaped cookies you can use to stir your coffee, to eat your ice cream, etc.

2. Marketing Plan

2.1. Proof of concept

With the aim of creating a sustainable, creative alternative that responds to various dietary restrictions and trends, we started research on the latest food products within the biscuit market. Motivated by the knowledge of products with national raw materials and that would meet the needs of the consumer, we wanted to know their reactions to a new, more sustainable product, made with chickpea flour, chestnut flour, rice flour and cinnamon, obviously not forgetting its distinctive format. In addition, with the study carried out, we also intend to understand the consumption and buying habits of consumers, as well as to carry out a socio-demographic analysis.

Thus, we carried out a questionnaire (Annex I), with a random sample of 89 responses. It should be noted that, as it is a random sample, we obtained age groups that, after some analysis, will not correspond to our Target, and that in a future questionnaire, we will proceed with a restricted sample.

In the survey, we found that 76.4% of respondents are regular consumers of biscuits, with more than 30% consuming them at least 3 to 4 times a week. Half of the sample also consumes the range of products accompanied by some type of drink, with more than 40% of respondents who prefer to accompany their biscuits agree that the best drink to do so would be coffee. This data helps to conclude in what way it is possible to communicate to a consumer with these

consumption patterns, for example, it would be beneficial to carry out a tasting brand activation together with a cup of coffee.

Respondents, in another spectrum of the analysis, indicated that they buy their biscuits with special attention to taste first, and then the price. However, when asked if they preferred Vegan cookies, gluten-free cookies or fiber rich cookies, more than 70% of the sample did not show interest in these consumption niches. With these overwhelming results, we analyzed the age groups, and of these more than 70%, 90% are under 25 years old. From these responses, we were able to obtain a clearer answer on who we should direct our target to. Thus, we conclude that people who are more concerned with these types of food niches are in an age group between 25 and 55 years old. The same is reflected with concerns about sustainability, where the majority of the sample did not show great concern, but when analyzing the age groups, it was possible to conclude that above the age group of 25 years, consumers show concern for more sustainable products than the rest.

Finally, we analyzed the respondents' interest in the main features of our product. To our surprise, more than half of our respondents were interested in consuming cookies made with chickpea flour, chestnut flour, rice flour and cinnamon, with a special preference for the latter. However, more than 50% considered that the shape of the biscuit being a spoon was indifferent to their consumption preferences, with only 37.1% identifying with its shape.

With this survey, it was then possible to see what adjustments could be made to the product and which consumer target we should aim for.

2.2. Consumer studies

As previously mentioned, a random sample survey was carried out, which obtained 89 responses, in which one of the objectives was to characterize the consumer profile and define the target audience. In the sociodemographic analysis, we can conclude that 73% of respondents are female and that 78.7% are aged between 18 and 25 years.

However, when analyzing the remaining sample responses, it was possible to conclude that this age group would not be the right one to define our target. Most respondents of the same age group responded that the main characteristics of our product, such as being vegan and gluten-free, were not a decisive factor for consumption.

Thus, after analyzing the remaining responses, we can conclude that the age groups that best suit our product are the age groups between 25 and 55 years old. However, according to the Marketest 2021 report, we can see that the consumption of cookies with sustainable characteristics has grown considerably in ages up to 65 years.

We can therefore conclude that the target for Spoon-eat biscuits is made up of consumers between the ages of 25 and 65, of both sexes (albeit with a greater predisposition for females), who are looking for new alternatives for consumption biscuits, preferably sustainable alternatives, and that identify themselves on some level with vegan and gluten-free products.

2.3. Evaluating market potential

To make a market analysis, it's helpful to consider the overall trend of consumer behavior in the country. According to data from Euromonitor International, cookies are a popular snack in Portugal, with many consumers purchasing them on a regular basis. However, the cookie market in Portugal is relatively mature (TGI, 2023), with relatively low growth rates in recent years. This suggests that competition in the market may be intense, and that manufacturers may need to differentiate their products in order to stand out.

In terms of consumer preferences, it's helpful to consider what types of cookies are most popular in the market. According to data from Euromonitor, traditional and regional cookies, such as the considered homemade "Biscoitos" or "Popias" are particularly popular in Portugal. On the other hand, today's market asks for more innovative and unique flavors, and the consumers value national ingredients in the making of the pastry.

One trend, that may be worth considering, is the increasing demand for sustainable and eco-friendly products in the Portuguese market. According to data from Eurostat, Portuguese consumers are becoming more aware of the environmental impact of their purchasing decisions and are increasingly seeking out products that are produced sustainably. This trend may be particularly relevant for the cookie market, as many cookies are packaged in single-use plastic packaging, which can be harmful to the environment. Manufacturers that are able to offer sustainable alternatives, such as biodegradable packaging or ingredients sourced from sustainable sources, may be well-positioned to meet the demand of environmentally conscious consumers. Brands can also contribute to sustainable causes by using more national products, as it will reduce the carbon footprint that importation would cause using foreign products.







In addition, it's worth keeping an eye on trends in the global cookie market, as these trends may eventually make their way to Portugal. For example, the popularity of healthier, plant-based, or low-sugar cookies may continue to grow (Marketest 2022), and manufacturers that are able to offer these types of products may find success in the Portuguese market.

In Portugal, up to the date of this document, there is still no commercialization of sustainable spoon-shaped biscuits, which also respond to other food trends, giving the Spoon-eat brand an innovative character and, therefore, a positioning advantage in the Portuguese market.

2.4. Competitor's analysis

In order to analyze Spoon-eat's possible competitors, it is necessary to consider not only biscuits with a similar shape that exist in other markets, but also biscuits with the same composition characteristics, such as being vegan or gluten-free. The entire biscuit market can be considered a substitute product, but for a more summarized analysis, we will analyze only the aforementioned attributes. Thus, in the table below, there is some information about possible competitors of the brand:

Table 1 - Benchmark

Photo	Name	Prices			Nutritional Information/100g	Claims		grams/un	total und/package
		Quantity (g)	€/package	€/Kg		gluten-free	Vegan		
	Natural Edible Dessert Spoons	192,5	13,62 €	70,75 €	373	No	Yes	7.7	25
	Vanilla Flavored-Small Edible Spoons	110	9,00 €	81,82 €	364	No	Yes	5.5	20
	Plain Flavored-Large Edible Spoons	92,25	9,00 €	97,56 €	325	No	Yes	6.15	15
	Colheres Comestíveis de café e gelado	126	5,99 €	47,54 €	270	Yes	Yes		
	Bolachas Maria sem Glúten	240	1,65 €	6,88 €	462	Yes	Yes		
	Bolachas Gengibre e Canela Sem Glúten	125	2,69 €	21,52 €	449	Yes	No		

For a more reliable analysis of the table, it is necessary to divide it into two aspects: the shape of the cookies and the gluten-free attributes. This happens because Spoon-eat would be the first biscuit commercialized in the Portuguese market with these characteristics.

Thus, when analyzing the first 4 products, it should be noted that the average price per kilo of biscuits in this format is around €75/kg, due to the technology and processes necessary to obtain the final product. It is also worth noting their nutritional value, most of which are above 300 kcal, and only one product is gluten-free. This gives the brand a commercial advantage, and also helps to compare prices that we might adopt when entering the market.

Although not mentioned in the table, it should be noted that the three brands of spoon-shaped biscuits are sold exclusively online, with none in traditional retail in the Portuguese market. When Spoon-eat launches itself into this distribution segment, it must take into account other types of expenses that e-commerce does not entail. However, it would be a positive point as it would be an innovative product to be present on national shelves.

The remaining products are in the table under review to compare nutritional values and what kind of dietary restrictions they follow, but the price per kilo should not be comparable since the production costs are significantly different.

2.5. Strategy, segmentation, positioning

From the analysis carried out, it was possible to elaborate the SWOT analysis described below:

Table 2 - SWOT analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> · Cookie made with 100% national product; · Sustainable and eco-innovative product, it does not exist in the national market; · Responds to various consumer needs (gluten-free, Vegan, high in fiber). 	<ul style="list-style-type: none"> · High price (at the level of “Premium” products); · High production costs, which depend on other industries; · Market considered “niche”.
Opportunities	Threats
<ul style="list-style-type: none"> · Growing demand for more sustainable food and packaging by consumers and investors; · Growth in the demand for foods that suit different dietary restrictions; · First Biscuit with these characteristics in the Portuguese market; · Increased use of social networks by the target audience, leading to better disclosure by the company in this area. 	<ul style="list-style-type: none"> · Loss of purchasing power, due to inflation in Europe; · Strong competition from substitute products in the market; · Reduced number of raw material suppliers; · Market in a maturation phase, making it difficult to penetrate the market.

Thus, based on the SWOT analysis and what was referred to in previous points, we defined the following:

Strategy: A strategy that Spoon-eat will be focusing on is differentiation. Given that the Portuguese cookie market is relatively mature and competitive, it may be difficult for the brand to compete on price alone. Instead, the brand will differentiate itself by offering unique and high-quality products that meet the needs and preferences of specific target segments. For example, the brand could, in the future, position itself as a leader in the growing market for vegan and gluten-free products, or as a pioneer in the use of sustainable packaging and ingredients.

Segmentation: As seen in the previous inquiry, the brand has considered its target to be people between the ages of 25 and 65, of both genders, who are looking for new alternatives for the consumption of biscuits, preferably sustainable alternatives, and that identify themselves on some level with vegan and gluten-free products. We could also consider health-conscious consumers who are willing to pay a premium or slightly elevated price for high-quality, specialty cookies, or on environmentally conscious consumers who are looking for sustainable alternatives to traditional cookies.

Positioning: With the brand’s target segments, we believe that a positioning strategy that effectively communicates the unique value and benefits of its products to these segments is the best strategy to approach. For example, the brand could position itself as a premium, indulgent treat for health-conscious consumers, or as a responsible and sustainable alternative to traditional cookies for environmentally-conscious consumers. By aligning its positioning with the needs and preferences of its target segments, the brand can effectively differentiate itself from competitors and build a strong and loyal customer base.

2.6. Marketing mix

The Marketing mix is often referred to as the “4Ps” in order to translate the marketing planning in practice (Goi, 2009). That said, we can define Spoon-eat’s “4Ps” as follows:

- **Product:** Spoon-eat is a brand of spoon shaped cookies, made primarily of chickpea flour mixed with rice flour, chestnut flour and cinnamon. We are considered a sustainable product, because we use byproducts from the portuguese industry, such as the chestnut flour, for example. Spoon-eat is very rich in fiber, and this comes due to the use of psyllium husk in its formulation. Spoon-eat’s innovation continues as this product is made using 3D printing technology, with it we can create different textures and new ways of experiencing food, following the trends. Thus, with these characteristics, we can characterize the product level as an expected product, because when the consumer buys our product, he already expects a series of characteristics promised in the act of consumption.

- **Price:** The stipulated price for Spoon-eat is 3,5€ per package of 64g (8 spoons) and 55€/Kg. This way, a Skimming strategy is adopted, since the brand has to start practicing prices considered premium to enter the market and, in the future, with another type of strategies, it may come to lower the price.

- **Placement:** For the distribution of Spoon-eat, the brand wants to invest, in an initial phase, in specialized commerce (e.g. “Celeiro”) and in e-commerce (e.g. brand 's website). Thus, the distribution strategy will start as selective distribution, as it is found in a selection of points of sale, but only in a market segment. In the future, the brand intends to expand to retail trade (ex: “Continente”) and HORECA trade and e-commerce (e.g. the brand's website), later transforming the strategy into extensive distribution.

- **Promotion (Communication):** As it is a new brand entering the biscuit market, investment in communication would be limited in an initial strategy. The brand considers it beneficial to carry out brand activations on commercial surfaces, with the aim of consumers tasting the product, creating memories of it in their minds. Another bet that the brand wants to follow are social networks. Despite our target being over 25 years old, according to the Pew Research Centrer, the growth in the use of social networks by people over 40 years old is increasing exponentially. Thus, Spoon-eat will bet on the use of digital communication, such as LinkedIn, Instagram or TikTok, as it generates more traffic and the algorithm is more favorable for brands and businesses than other networks. The brand will also bet on a sales force strategy, such as occasional discounts at the point of sale or on the website. Also, to take advantage of the existence of the website, bet on SEO and digital marketing, using Google Ads. Finally, when the brand is more established in the market, we can bet on large-scale communication, such as OOH platforms (mupis, billboards, etc.) and even television communication.

2.7. Communication strategy

Our main objective with the communication strategy is to introduce and publicize a new product in the market: Spoon-eat. In order for the consumer to identify himself with our brand, we want to make known the process that makes our cookies sustainable and clarify that we give preference to national products.

Our priority is notoriety, since the market does not know us, we must bet on communicating in ways that bring us traffic and coverage more quickly. These media, in Portugal, are television and social networks.

Due to the limited budget that a brand who is still entering the market has, opting for television communication is ambitious. So, in the first years, we had to bet, essentially, on three main bases: social networks, communication at the point of sale and market activations for tasting. Social networks, therefore, will create more traffic to our pages, and increase brand awareness. It also creates a good link between brand and consumer, since the public can interact directly with us. The social networks that we should bet on, in a first wave, would be LinkedIn, Instagram (@_spoon_eat_) and Tiktok, for the reasons explained above. Communication at the point of sale, such as in supermarket trolleys or posters posted at the location would be our best bet in this area, since cookies are low-impact products, being present at the point of purchase would remind them of the brand's existence and increase the likelihood of purchase. Finally, brand activations. These would also take place at the point of sale, with the aim of giving the customer a taste of our product. It would also be beneficial to bet on this strategy, together with other brands, such as coffee brands in the growth phase, to introduce consumers to new forms of consumption.

At a more advanced stage, Spoon-eat would bet on mass-media communication, such as television communication and OOH (out of home), to have a greater reach of the target audience and even reach new types of consumers.

2.8. Brand and packaging

The idea of the brand name Spoon-eat came from a pun that referred to "sticking the spoon in something" (Spoon it), and the act of eating, since it is a brand of edible spoons. Thus, the expression was adapted to the final name of the brand.

The selected logo design (Figure 1) for Spoon-eat embraces a retro aesthetic to reflect its innovative and unconventional nature. The primary objective of the logo was to be distinctive and dynamic, aligning with Spoon-eat's core values. To achieve this effect, the "Prosa GT" font, with commercial usage rights, was employed, with slight modifications made to three letters. This subtle differentiation injects dynamism into the logo, reinforcing the brand's commitment to being unconventional.

Additionally, the logo prominently features a spoon, serving as a direct reference to the product itself. This spoon element is also utilized in the smart logo version (Figure 2), along with the brand's catchy slogan, "Spoon-eat, a spoon you eat." The integration of the spoon motif across the logo and graphic identity design patterns ensures visual consistency and reinforces the brand's identity.

The foundational color palette of white, black, and burgundy was chosen with sustainability in mind, particularly when printed on packaging card materials. These versatile colors can be easily incorporated into future designs, allowing for flexibility and adaptability while maintaining brand cohesiveness.



Figure 4 - Sides of the Package

3. Technical studies: formula process and flowchart

3.1. Innovation

Our spoons are not regular spoons. Not only are they edible, but they're also 3d printed, making the fabrication process more eco-friendly because this manufacture technique prints the spoon layer by layer, leaving little leftover waste or excess material in the process. The leftovers that do exist go to a different batch that reaches the customer at a lower price, since they can't be printed with the shape of a spoon but have the same taste and texture as a regular spoon of ours. We call them "ugly spoons".

Besides the innovation in the technology that is used to fabricate our spoons, we also use Portuguese ingredients, that are not used very often in the formulation of products that exist currently on the market and that are byproducts of other industries, such as the chestnut flour and the rice flour.

3.2. Formula development process presentation

Our path wasn't clear and free of obstacles, it was steep and had a lot of rocks in the way, which with perseverance and a lot of teamwork we were able to overcome and end with a formulation of everyone's liking. It wasn't easy at all. We went over more than 30 different formulations, with various flours, spices, ratios of water and olive oil, hydrocolloids, and so on so that we could achieve the best formulation possible.

Here goes a little glimpse of our rocky, hard road to greatness.

Our first prototype wasn't a spoon, it was an attempt to make a little cup, that came out a disaster (Figure 5). Our idea at the start was to make an edible cup with apple jam (made with apple peels) inside, but we quickly realized that this shape was very hard to achieve with our type of dough.



Figure 5 -The first prototype of our product

Not letting go of the idea of having jam in our product yet, we tried to make a spoon in our 3d printing machine (Figure 6). It came out reasonable, but the texture we were looking for was not quite there. Our formulation made the spoons come out with an undercooked bread texture while we were looking for a crunchy light texture. This was our biggest challenge in the creation of our spoons.



Figure 6 - A prototype of our product with apple jam

Although the apple jam made an incredible addition to the flavour of our spoons, while also adding a new texture (the spoons were supposed to be crunchy and the jam added a jelly-like texture), we realized that the product would not hold up the desired characteristics for very long because of the humidity that the jam confers. For that reason, we had to drop the idea of having spoons filled with jam, and from this moment on we focused on achieving the best formulation possible for the creation of our crunchy light spoon.

Since our spoons weren't presenting the texture we would like, we adjusted our formulation, not only to the ratio of water and olive oil used but also to the hydrocolloids that we were using. We had to add hydrocolloids to our formulation because our product is gluten free and the 3d printer is only able to print doughs that fulfill certain requirements, such as being moldable enough for the printer to be able to force it out of the cartridges (extrusion) through the nozzle. This has to do with the materials printability and rheological properties, such as flow, viscosity, and yield stress (Pereira, T. et al., 2021).

Overall, we made formulations with eight different hydrocolloids: Xanthan gum, psyllium husk, inuline, citric fibre, k-carrageenan, carob gum, guar gum and HPMC. Furthermore, in terms of flours, we made formulations with eight different flours: chestnut, carob, apple, chickpea, rice, buckwheat, acorn and wheat flour. Some of our formulations turned out to be too watery, making the spoon come out with an embroidery look (Figure 7), and some had a percentage of water so low that the printer couldn't even print the dough.



Figure 7 - A prototype of our product with an embroidery look

In all the previous steps, we took care to collect data on the quantity of each ingredient used, as well as relevant characteristics of our product, such as the texture of raw dough, performance of the 3D printing process, flavor, and texture. This data played a vital role in

determining the optimal formulation, enabling us to conduct a comprehensive analysis and apply a clustering machine learning model to uncover similarities among all the formulations.

Using the Python programming language, an exploratory analysis was initially conducted to obtain an overall overview of some characteristics of our product. The analysis revealed that only 18% of our formulations had a desirable raw dough texture, while the majority (73%) had a fluid texture. Additionally, only 32% demonstrated good printing performance. In terms of flavor, the majority (76%) had a desirable flavor. And lastly, only 18% were found to be crunchy (Annex II). To determine the best formulation, a cluster analysis was conducted. The elbow method and dendrogram method were used, resulting in the identification of three clusters within the data. The dendrogram in Annex-III illustrates these clusters. By applying K-means and hierarchical clustering techniques, we were able to generate clusters that group together formulations with similar ingredients and characteristics of the final product. This means that recipes within the same cluster share common attributes in terms of the ingredients used and the resulting qualities of the product. These clusters help us identify patterns and understand which combination of ingredients and their quantities lead to specific characteristics in the final product. Analyzing the formulations within each cluster provides valuable information for optimizing formulations and achieving desired product outcomes. Furthermore, based on the cluster analysis, we have identified the best 4 formulations that achieve the desirable product outcomes.

Finally, after considering various factors including nutritional scores, we concluded that the best formulation consisted in a mixture of three flours: chickpea, chestnut and rice flour, two different hydrocolloids: psyllium husk and HPMC and that the perfect percentage of water and olive oil for our product is 34,5% and 4,1%, respectively (Figure 8).

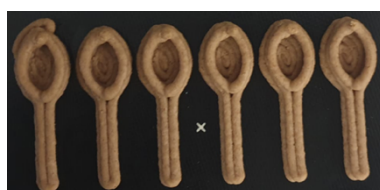


Figure 8 - Our product with the final formulation

3.3. Details in constitution, process flow chart and technical characteristics

After achieving the perfect balance of ingredients for the best palatable sensation to the consumer, our percentage of ingredients are: water (34%), chickpea flour (27%), rice flour (16%), sugar (11%), olive oil (3,7%), chestnut flour (3%), psyllium husk (2%), cinnamon (1,4%), salt (1%) and HPMC (0,9%). In terms of the fabrication of our edible spoons, we act in accordance to the following process flow chart:

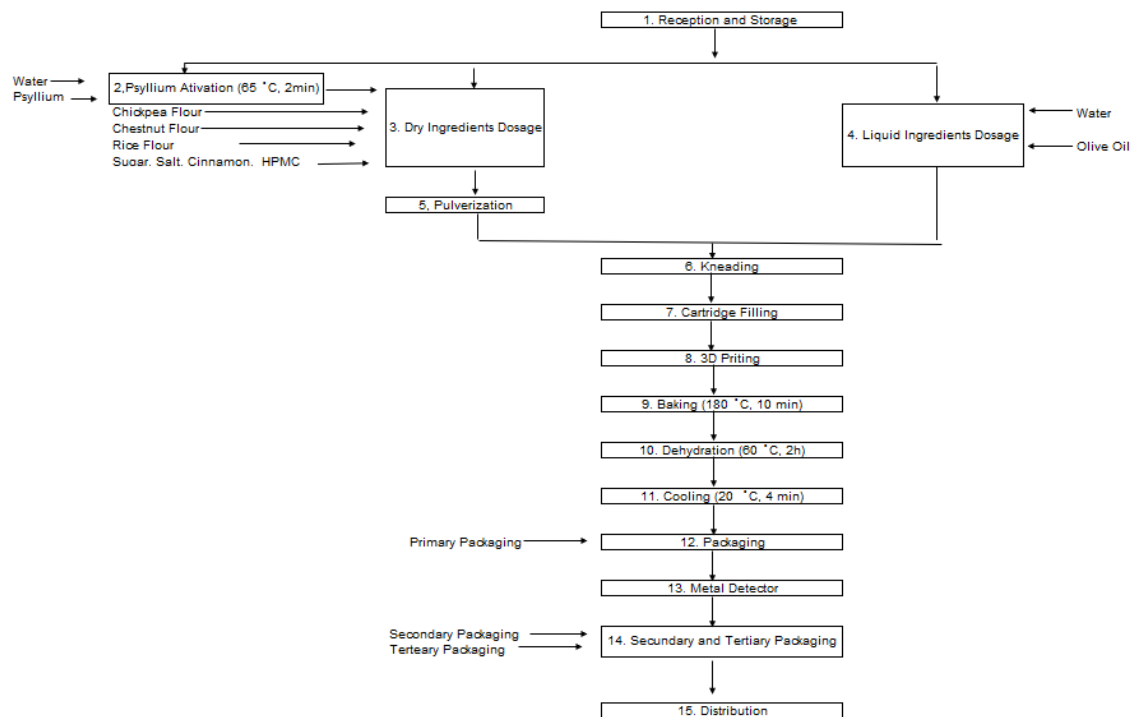


Figure 9 - Process flow chart of Spoon-eat

The technical characteristics of Spoon-eat are the following.

Table 3 - Technical characteristics of Spoon-eat

Product/Process	Chickpea, rice and chestnut flour 3D printed edible spoons. All the dry ingredients are mixed together and pulverized. Then, these ingredients are added to the wet ingredients, mixed well and then placed in the cartridge. After being 3D printed, the spoons are baked for 10 minutes at a temperature of 180°C, followed by a dehydration process at 60°C for 2 hours. After this, the spoons cool down at a temperature of 20°C for 4 minutes and are packaged.
Characteristics of the Final Product	Crunchy and light. Sustainable and Innovative. High in Fiber. Vegan and Gluten-free.
Raw material/Ingredients	Water, chickpea flour, rice flour, chestnut flour, sugar, olive oil, psyllium husk, cinnamon, HPMC and salt.
Type and conditions of packaging	Cellulose fiber bags (primary packaging); Recycled cardboard box (secondary packaging).
Storage conditions	Store in a cool, dry place. After opening, consume right away.
Shelf life	At least three months.
Type of distribution/Comercialization	E-commerce and specialized commerce.
Allergenic	Contains Chestnut.

Label instructions	High Fiber. Vegan. Gluten-Free. "Portugal Sou Eu". Source of protein.
Applicable legislation	Implementing Regulation (EU) 2017/2470 of the European Commission, <i>Codex Alimentarius</i> - General Principles of Food Hygiene
Intended use for the Final Product	Ready to consume.

3.4. Sensory analysis, validation of microbiological quality (shelf life/expiration date)

A sensory analysis was conducted with 32 potential consumers, where the results were generally very positive. From the results, which are presented in Annex IV, we highlight the appearance, where 90.6% of consumers found it pleasant or very pleasant, the flavor, where 65.7% of consumers classified it as pleasant or very pleasant, and in terms of overall appreciation, 75% of consumers classified our edible spoons as pleasant or very pleasant.

Due to lack of time, it was not possible to perform study tests related to shelf life. Thus, a survey of shelf lives for products with properties like ours was carried out and with the acquired information, Spoon-eat's are expected to have a shelf time of at least three months.

To evaluate the hardness of the product, a texture analysis was conducted using a texture analyzer. A total of 28 samples were analyzed, and it was observed that the average force applied to the middle of the spoon was 45.16 N and to the handle was 47 N. In order to determine if these differences are significant or not, a Mann-Whitney test was conducted, as the data did not meet the assumptions for performing a parametric test. The results of the Mann-Whitney test showed a p-value of 0.8, considering an alpha value of 0.005. Since the p-value was higher than the alpha value, it was concluded that there aren't significant differences in crunchiness between the handle and the middle of the spoon. Additionally, it is possible to consider the spoon as an overall hardness of 46 N. Considering a study by Carrilho, L., in 2014, on the development of gluten-free biscuits using industrial by-products, different formulations of biscuits were analyzed. In one of the formulations, which included rice flour and olive oil as fat, a value of approximately 20 N was obtained. This indicates that our product has a significantly higher firmness compared to conventional biscuits currently available in the market (Carilho,2014).

3.5. Technical characteristics of packaging for the product's preservation

The cellulose fiber bags used in the primary packaging of Spoon-eat's are entirely made of cellulose fiber from wood, making them completely biodegradable, compostable but also moisture proof, which keeps the freshness of our spoons. The secondary packaging is made out of 100% recycled cardboard and its purpose is to protect the structure of our product during transportation.

3.6. Nutritional properties and health benefits: justification

As stated in the table below, our spoons contain 250Kcal per 100g and 20Kcal per individual spoon and are high in fiber (since they contain more than 6g of fiber per 100g) and are a source of protein, since 12% of its total kcal content comes from protein.

Table 4 - - Nutritional Value of Spoon-eat's Spoons

Composition	Per 100g	Per spoon (8g)	%DV per 100g	%DV per spoon	DV
Energy (kJ)	1046	83,7	12,5	1,0	8400
Energy (Kcal)	250	20,0	12,5	1,0	2000
Total Lipids (g)	5,5	0,4	7,9	0,6	70
Saturated fatty acids (g)	2,2	0,2	11,0	0,9	20
Carbohydrates (g)	38,9	3,1	15,0	1,2	260
Sugars (g)	14,8	1,2	16,4	1,3	90
Dietary fiber (g)	7,5	0,6			
Protein (g)	7,5	0,6	15,0	1,2	50
Salt (g)	1	0,1	16,7	1,3	6

Micronutrients	Per 100g	Per spoon	%DV per 100g	%DV per spoon	DV
Phosphorus (mg)	107,0	8,6	15,3	1,2	700,0
Copper (mg)	0,2	0,01	17,0	1,4	1,0
Manganese (mg)	0,9	0,1	42,7	3,4	2,0

The nutritional benefits of our product don't stop at the nutritional value table. Since one of our primary ingredients consists of chestnut flour, which is a functional food (meaning that it offers health benefits beyond their nutritional value), our spoons are a rich source of polyphenols, which, according to some studies, confer protection against development of certain cancers, cardiovascular diseases, diabetes and neurodegenerative diseases.

Dried fruits are important allies in our health, since they contribute to cholesterol reduction, reduce the risk of cardiovascular diseases and help control blood pressure, prevent type 2 diabetes since they are rich in starch as opposed to simple sugars and help reduce appetite. In addition, chestnuts are low in fat.

Chestnuts are an excellent source of fiber, which helps prevent constipation and facilitate control of bowel movement. In its composition is also present soluble fiber, which can reduce blood sugar levels and contribute to reducing cholesterol (Choupina, 2019).

In addition to chestnut flour, our spoons contain chickpea flour, known for being high in fiber and protein. Like chestnut flour, chickpea flour also contains a high dietary fiber content and provides the same potential health benefits. Chickpeas are a source of vitamins and minerals, including iron, magnesium and B Vitamins, and according to some studies, pulses, in which chickpeas are included, have a low glycemic index, meaning they can help regulate blood sugar levels and reduce the risk of developing type 2 diabetes. For being a rich source of protein, chickpea is an important component of the diets of individuals who cannot afford animal proteins or those who are vegan or vegetarian by choice (Jukanti et al., 2012).

Our spoons also contain psyllium, a soluble fiber widely used to regulate constipation that has been shown to play a role in the treatment and prevention of intestinal diseases such as irritable bowel syndrome and inflammatory bowel disease, with some studies suggesting that it may even prevent colon cancer. In addition, dietary supplementation with psyllium has been shown to help reduce blood cholesterol (LDL) levels as well as maintain glycemic homeostasis and is therefore effective in preventing both diabetes and cardiovascular diseases (Wärnberg, 2009).

HPMC stands for hydroxypropyl methylcellulose and is a key ingredient in our formulation as a hydrocolloid, just like psyllium. This compound contributes to a reduction of the blood glucose rise after meals and contributes to the maintenance of normal blood cholesterol levels, if consumed in more than 4 or 5g per day, respectively (EFSA Panel on Dietetic Products, Nutrition and Allergies, 2010).

4. Technological studies: simulating production at an industrial scale.

4.1. Identifying potential suppliers for industrial production

In order to achieve a final product of excellence, it is essential to count on quality and local raw materials. In this way, considering various criteria, a selection process was carried out of all potential suppliers. For this selection, the quality of the raw material, certifications, proximity, and price were taken into consideration.

Considering the selection criteria mentioned above, the suppliers chosen to obtain the different raw materials are:

Cerealis (chickpea flour): Nacional is a portuguese company with IFS, Halal and Kosher certifications;

Sortegel (chestnut flour): a reference company, located in Bragança, in the transformation and exportation of chestnut. It has Global G.A.P, Bio, Biosuisse Organic certifications;

Próvida (rice flour): a company based in Raposeiras, municipality of Sintra, which sells a wide range of natural and healthy products, including rice flour;

Oliveira da Serra (olive oil): company specialized in olive oil production, belonging to the Sovena group, and located in Ferreira do Alentejo. It is ISO 14001 and ISO 22000 certified;

Sidul (sugar): Portugal's largest sugar refinery in Santa Iria de Azóia,

Vatel (salt): the brand belongs to the K+S group, one of the world's leading salt producers in the world. Vatel is located in Alverca and Olhão, and is ISO 9001 and IFS certified;

Seara (Psyllium): company based in Mem Martins, Sintra, which specializes in the sustainable production of organic products.

Suldouro (cinnamon): a company located in Gaia, specializing in the marketing of spices and herbs. It's ISO 9001 certified;

Embalsantos (Primary Packaging): portuguese company, located in Pataias, specialized in offering packaging solutions;

Raja (Secondary Packaging): a leading European packaging distribution company, located in Cacem.

In order to monitor and control the performance of suppliers, it's intended to carry out annual audits. In these audits, the intention is to control and evaluate the fulfillment of cleaning and hygiene plans, the conditions of the establishment, the control of contaminations, the management of food safety management, equipment control, among other aspects involving all suppliers. As the company intends to count on quality raw materials, an analysis of non-conformities, product quality and analysis of analysis bulletins discloses by the supplier are also performed.

4.2. Implementation of process at an industrial scale: proposition for the production line

Considering the production process, a proposal for a production line was designed. This is represented in Figure 1 of Annex V, where the blue arrows correspond to the route of raw materials, while the green arrows correspond to the route of packaging materials.

4.3. Description of the layout's characteristics throughout the production process

In the reception zone, the raw materials are received and weighed. The hygienic and sanitary conditions are guaranteed by the supplier, who, for this purpose, each batch of raw material received must be accompanied by the following documents: analysis bulletin; cleaning certificate of the tank and tank seal, if the raw material arrives via tanker trucks. Samples are taken from them to perform physicochemical analyses. In what concerns chestnut flour samples, as they come from non-compliant chestnuts, besides the analysis performed in the company's laboratory, they are also sent to an external accredited laboratory. In the case of chestnut flour, chickpea flour and rice flour, the moisture content, acidity, and presence of gluten are analyzed. About olive oil, the peroxide, acidity, and saponification index are analyzed. Regarding the reception of the packaging material, the presence of any structural anomaly is visually inspected.

After all analyses have been carried out and the respective results obtained, all the raw materials which have been shown to be acceptable according to our quality parameters, are stored in the dry raw materials warehouse at room temperature, around 20 °C. While the packaging materials are stored in the warehouse for packaging materials.

Since psyllium fiber needs to undergo a hydration process to perform its function, it goes to a stirring tank with water at a temperature of 65°C for 2 minutes. Then, the dosing of dry raw materials (chestnut flour, rice flour, sugar, salt, cinnamon and hpmc) and liquid raw materials (water and olive oil) takes place automatically.

Since granulometry is a very important aspect for the proper functioning of 3D printing, it's necessary to do a pulverization of the dry raw materials. In this operation, the dried raw materials are introduced into a pulveriser to ensure that the mixture has the desired granulometry. This is followed by a kneading process in a mixer, where the dry and liquid ingredients are mixed and homogenized to obtain a homogeneous mixture with the appropriate rheological characteristics.

In order to start the 3D printing process, the 3D printing cartridges are first filled manually and then inserted into the 3D printing machine. After 3D printing, the spoons are placed into an oven, which is carried out at a temperature of 180°C for 12 minutes. In order to achieve the desired crispness, after baking, the spoons are placed in a dehydrator at a temperature of 60°C for two and a half hours. Before being packed, the spoons are cooled down, where they are transported to a cooling tunnel for 4 min at 20 °C. After being cooled, the product is automatically packaged in the primary packaging. With the purpose of protecting the consumer, all packages go through a metal detector that allows the identification and removal of metallic contaminants. Then, the secondary packaging takes place, where the product already in the primary packaging is placed in the secondary packaging (boxes), which are then placed in the tertiary packaging (pallets).

4.4. Risk evaluation

To avoid potential risks that may cause harm to consumers, the HACCP plan was carried out. This system is based on a preventive methodology, through the elimination or reduction of hazards, guaranteeing that unsafe food is not available to the consumer (Mil-Homens, 2007). According to the Codex Alimentarius, in order to implement a HACCP system, dangers and critical control points were identified throughout the entire production process, applying the 7 principles of the HACCP plan. During the whole production process, the standards mentioned in topic 5 were complied with, being that, for the elaboration of the HACCP plan, the compliance with the Regulation (EC) N° 852/2004, regarding food hygiene, and the NP EN ISO 22000:2005, that

concerns the prerequisites of a food industry, guaranteeing the compliance with the prerequisites in all the processing stages, where preventive and control measures were defined. This HACCP plan is represented in Table 1 of Annex VI.

5. Law studies (current legislation)

5.1. Naming and designation rules

Nowadays, there is no legislation that fits the designation chosen for our product, which is Spoon-eat.

5.2. Food labeling

The label for Spoon-eat was created in accordance with Regulation (EU) No. 169/2011 of the European Parliament and of the Council from October 25th 2011, on the provision of food information to consumers. This regulation sets and approves new food labeling rules and updates the European Union rules applicable to the labeling of foodstuff.

5.3. Nutritional and health claims

Spoon-eat cookies are also considered “High Fiber”, since they contain 6 g of fiber per 100 g of product, this content being adequate for the use of the claim, according to the Regulation (EC) No. 1924/ 2006 of the European Parliament and the Council of December 20th 2006. They are also considered a Source of Protein since this claim may only be made where at least 12 % of the energy value of the food is provided by protein according to the Regulation (EC) No 1924/2006. We can also consider Spoon-eat cookies to be a source of copper, phosphorus, also containing a high manganese content according to the Regulation (EC) No 1924/2006.

5.4. Food additives and ingredients

According to the Regulation (EC) No. 1333/2008 of the European Parliament and of the Council, of December 16th 2008, concerning food additives, the food additive E464, hydroxypropylmethylcellulose (HPMC), is authorized for incorporation into foodstuffs as a gelling agent or suspending, emulsifying, stabilizing and thickening agent; having no adverse effects. Regarding the use of psyllium fiber, this is a natural ingredient and is not considered an additive, so it is used as an ingredient and is not regulated.

5.5. *Novel food*: authorization

According to the Regulation (EU) 2015/2283 on novel foods, foods that result from a production process not used for the production of foods in the European Union before May 15th 1997, such as the 3D printing of the Spoon-eat cookies, are considered novel foods.

5.6. Quality management systems

M4RS is certified by the Portuguese norm for Quality Management Systems (ISO 9001:2015), relating to the requirements of a quality management system to be used whenever an organization needs to demonstrate its ability to supply products that satisfy both the requirements of its customers, such as applicable regulations, with a view to increasing the satisfaction of our customers.

5.7. Food Safety

During all the stages of production, from the reception of raw materials to the dispatch of the final product to large supermarkets, the Regulation (EC) No. 852/2004, on the hygiene of foodstuffs, is followed. In addition, all prerequisites are met at all stages of the product formulation process, and all preventive and control measures for a food industry are defined in accordance with NP EN ISO 22000:2005. For this, a hazard analysis was carried out and the respective identification of the Critical Control Points, for which the 7 HACCP principles present in the Codex Alimentarius were applied (Codex Alimentarius, 2020).

5.8. Packaging

The packaging used to pack the Spoon-eat cookies complies with Regulation (EC) No. 1935/2004 on materials and objects intended to come into contact with food. Under correct conditions of storage and use, it is guaranteed that no migration of compounds from the packaging material to the food product occurs, in quantities that could pose a danger to consumers, cause unacceptable changes in the composition of the food product or cause a deterioration of the organoleptic characteristics of the food.

5.9. Advertising

According to Decree-Law No. 330/90 from October 23rd, advertising that offends the fundamental principles, values and institutions constitutionally enshrined is prohibited. This must always be unmistakably like advertising, regardless of the medium of transmission, and must respect the truth.

6. Sustainability aspects

Spoon-eat was created with a clear objective, to be the most environmentally sustainable it could be, we have gone through every step that makes this possible and we believe we have achieved what we set out for.

Spoon-eat has 3 main pillars in terms of sustainability: using primarily Portuguese raw materials, using byproducts of other industries and 3D printing.

By using mainly Portuguese raw materials we are able to have a small carbon footprint associated with transportation, the less Km our raw materials travel, the less polluting they will be, with this mindset we always prefer Portuguese suppliers for everything we need. We also have a very strict intention of never letting any truck go empty from our factory, when a truck that's able to ship out our product comes to deliver raw materials we clean the truck and load it with finished product to be distributed, so we can take advantage of their routes and minimize fossil fuel consumption.

We also incorporate chestnut flour into our formulation, which in this case is a direct byproduct of frozen chestnut production, also rice flour that can be obtained from the broken rice generated from a typical rice production and finally chickpea flour, chickpea flour offers numerous sustainable benefits, chickpeas are a drought-resistant crop that requires minimal irrigation, making them an ideal choice for water-stressed regions. Additionally, chickpeas are a nitrogen-fixing crop, which means they help improve soil health and reduce the need for synthetic fertilizers. Furthermore, using chickpea flour as a plant-based alternative to wheat flour can help reduce the environmental impact of the agricultural industry, as producing wheat requires significantly more

water and energy than chickpeas. Overall, incorporating chickpea flour into our diets can not only benefit our health but also contribute to a more sustainable food system. Also it's worth mentioning that our country has enough chickpea production for us to rely on, making it a short supply chain, thus further lowering the carbon footprint associated with the product.

By doing this we are stimulating a circular type of economy that can lead to saving money, decreasing the annual emissions of green-house gases generated (food industry alone generates 30% of greenhouse gas emissions), increasing competition and stimulating an eco-friendly innovation.

Food waste is the cause for about 10% of greenhouse gas emissions so we want to do something about it, here comes 3D printing technology, research says that this technology can help mitigate food waste generation by only printing what's necessary and in our case minimizing dough waste, it is possible to recover leftover dough from each production and reintroducing it in production, this way we can minimize our food waste.

It is a fact that some of our production steps required a lot of energy to function, with this in mind we plan on opting for more sustainable energetic alternatives such as solar panels.

7. Financial analysis: 3 year simulation

To carry out the 3-year financial analysis simulation, first a cost analysis was performed, taking into account costs such as packaging, raw materials, marketing and advertising, costs associated with energy, sanitation, water, distribution, utensils, cleaning and fixed costs such as salaries and rent. On the other hand, production equipment, dining room furniture, such as tables, chairs, microwave oven, coffee machine, and administrative area furniture, mainly computers, chairs and desks, were accounted for. Next, the cost per kg of the finished product was calculated as shown in table 2 in annex VII, and based on the market analysis, the selling price per kg was defined (55 euros), with a gross margin of 55% for the first year, 67% for the second year and 73% for the third year as shown in table 2 in annex VII.

Sales are estimated at 400 kg per month for the first year, 600 kg for the second year and 800 kg for the third year. To achieve this, an investment of 112,000 euros is required in year 0, in order to acquire the necessary equipment for the production and operation of the company (table 3, annex VII).

In table 3, in annex VII are represented the project's operating expenses, and the gain by sales, per year, from year 0 to year 3. A variable sales model was assumed during the first 3 years. A sales price of 55 euros per kilogram of finished product was taken into account for the calculation of sales.

From the financial indicators presented in table 5 in annex VII we can see that the fact that the NPV is positive indicates that the benefits generated during the useful life period would be sufficient to ensure the recovery of the capital invested and also allowing for a residual benefit of €107 705. Additionally, as shown in table 5, the IRR for which the net present value is zero is 28%. This means that the annual return produced during the 3 years of useful life of the investment, after recovering the investments and operating costs is 28%. The Benefit-Cost Ratio, on the other hand, shows the relative profitability of the business since it is greater than one, so the benefits are greater than the costs. Finally, the payback period for the project is 3 years. This indicates that starting in the third year the company begins to benefit from the sales revenues.

The following figure shows the business model canvas for the company Spoon-eat.

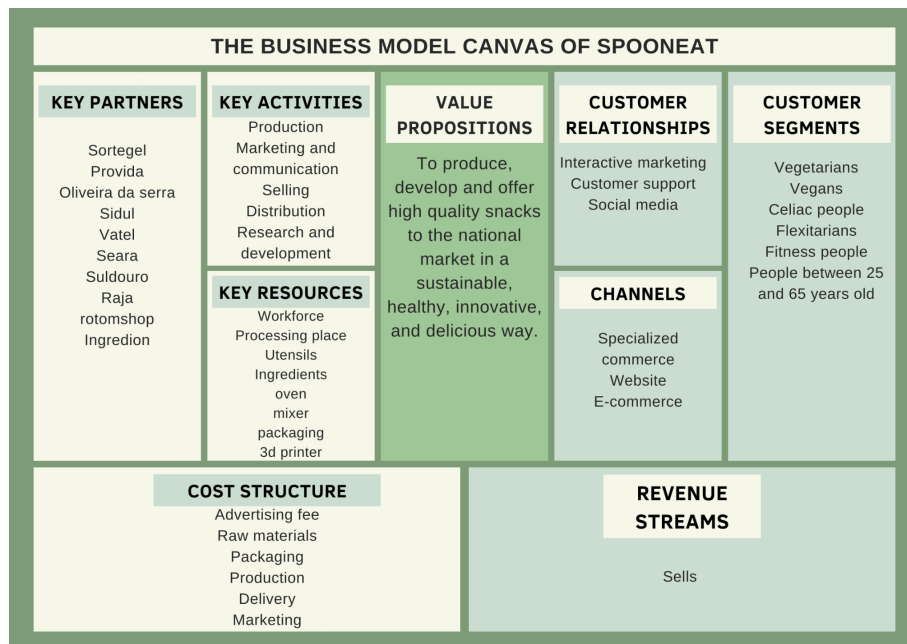


Figure 10 - Business canvas model of spoon-eat

8. Project's consistency

Spoon-eat has great market potential, such as has been shown throughout this paper, our product is innovative, sustainable and healthy. Right now we are aware that our product is priced as a premium product but our aim is to, in the future, drop our prices as demand rises, making our product more competitive and affordable.

The sale of spoon-eat, in Portugal, is viable, because according to the profitability indicators carried out for the cash flow before financing, the net present value is €106 000 euros with an IRR of 27% and a payback period of 3 years.

Keeping in mind that we have to protect our innovative ideas, we will take measures to ensure our formulas are never revealed, such as not allowing any type of image recording inside the labs or offices and the creation of a patent for our formula, because although edible spoons exist, none of them are 3D printable and we think our efforts are worth saving that way. If a patent proves itself to not be worthy, we can rely on trade secret to keep our ideas and formulas safe.

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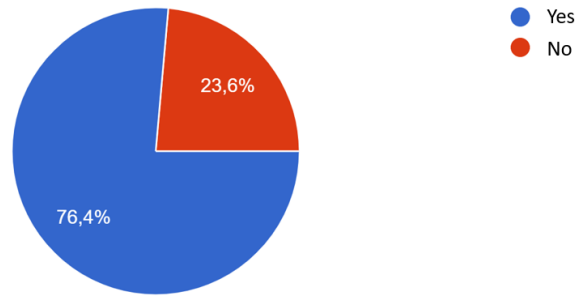
Annex

Annex I - Survey graphic analysis

Figures 1 to 14 - Potential consumer survey results

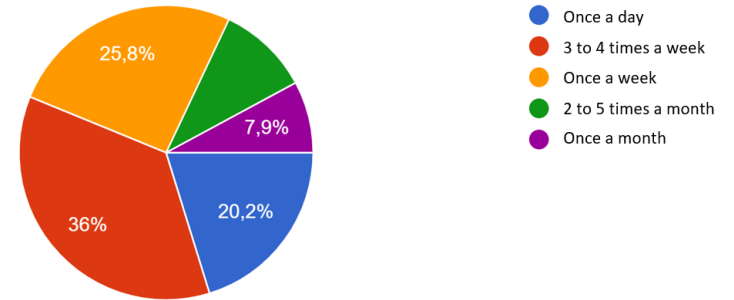
Do you usually consume cookies in your everyday life?

89 Answers



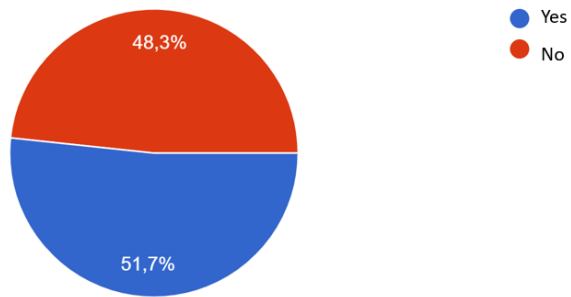
How often would you say you consume cookies?

89 Answers



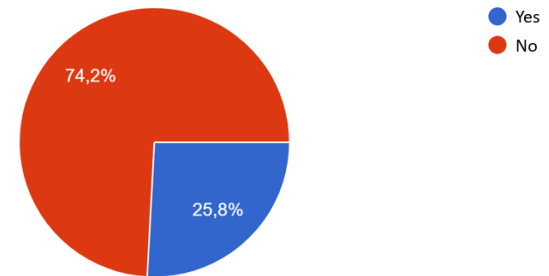
When you consume cookies, do you usually accompany them with a drink?

89 Answers



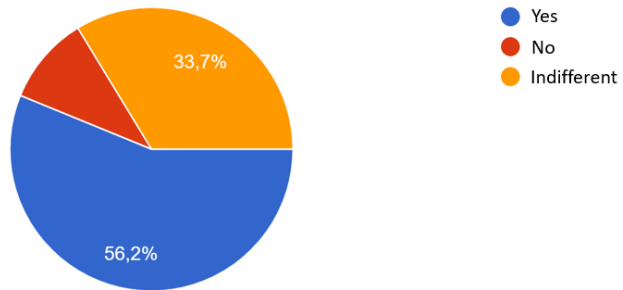
When you buy cookies or some food product, do you prefer products that are sustainable, regardless of the price?

89 Answers



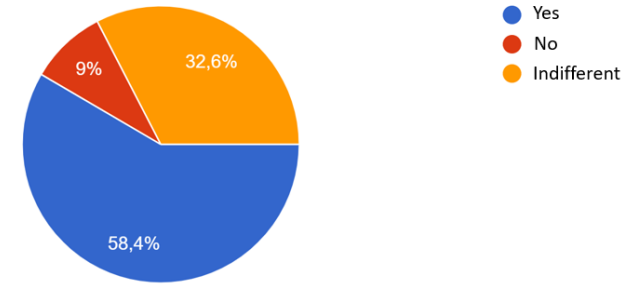
Would you be interested in eating cookies made with chestnut flour?

89 Answers



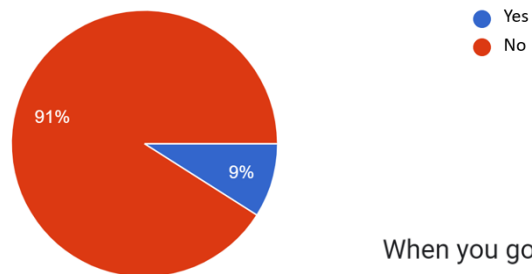
Would you be interested in consuming crackers made with rice flour?

89 Answers



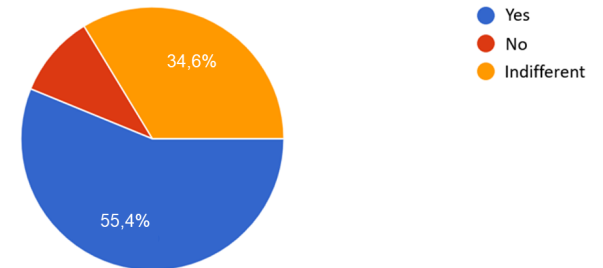
When you go shopping for cookies, do you prefer gluten-free cookies?

89 Answers



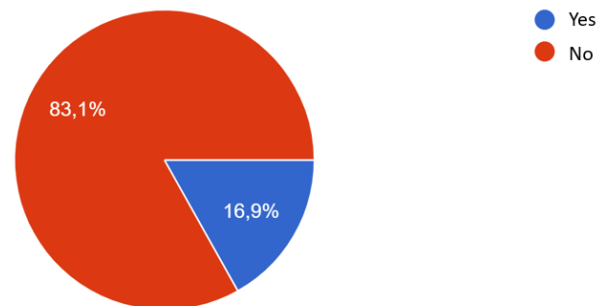
Would you be interested in eating cookies made with Chickpea flour?

89 Answers



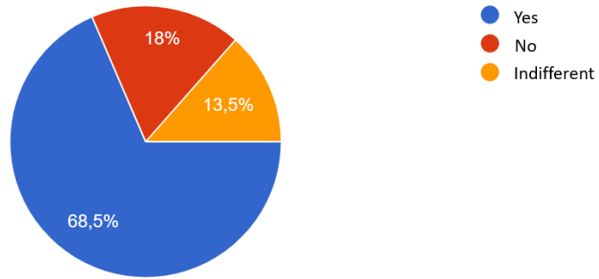
When you go shopping for cookies, do you prefer fiber-rich cookies?

89 Answers



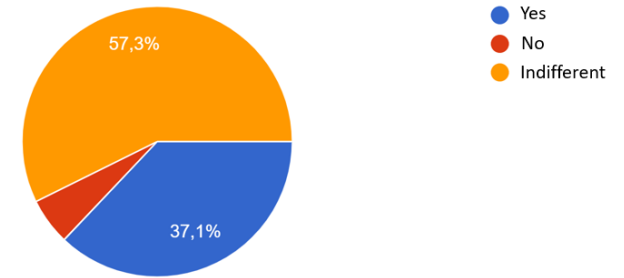
Would you be interested in consuming cookies with cinnamon in your constitution?

89 Answers



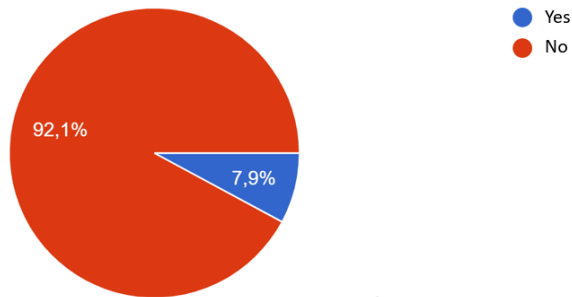
Would you be interested in consuming spoon-shaped cookies?

89 Answers



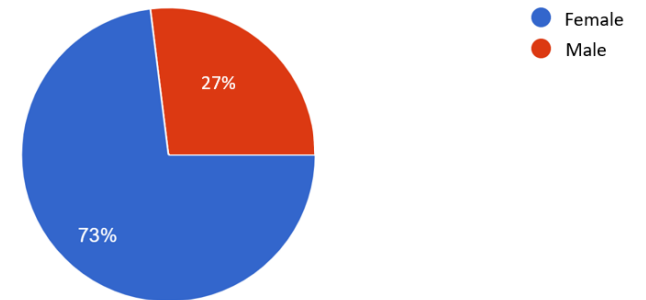
When you go shopping for cookies, do you prefer Vegan cookies?

89 Answers



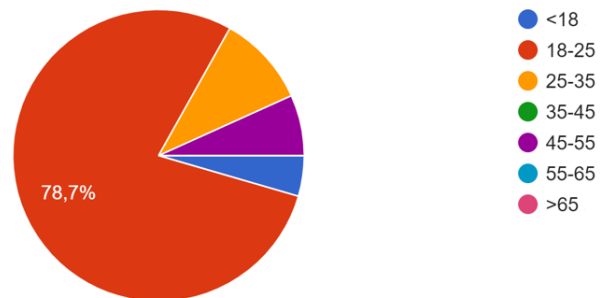
Gender:

89 Answers



Age:

89 Answers



Annex II- Exploratory Data Analysis Results

Figure 1: Texture of Raw Dough in All Formulations

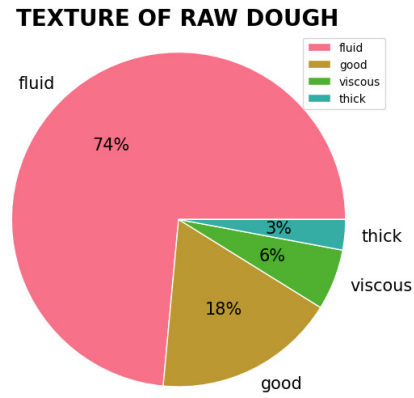
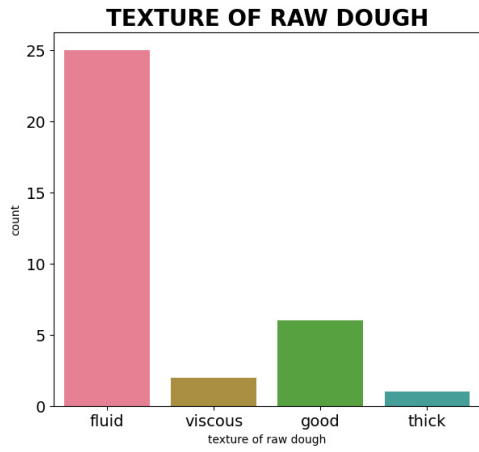


Figure 2: Printing Performance of All Formulations

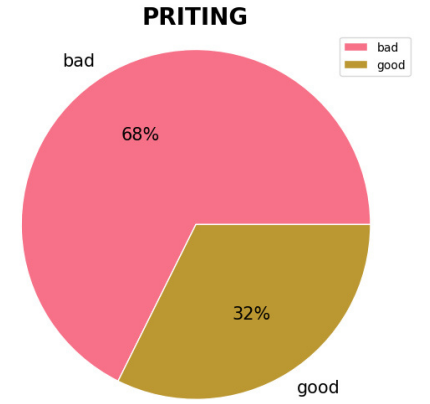
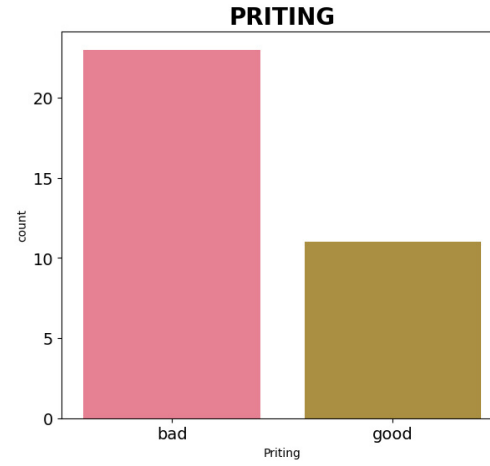


Figure 3: Flavor of All Formulations

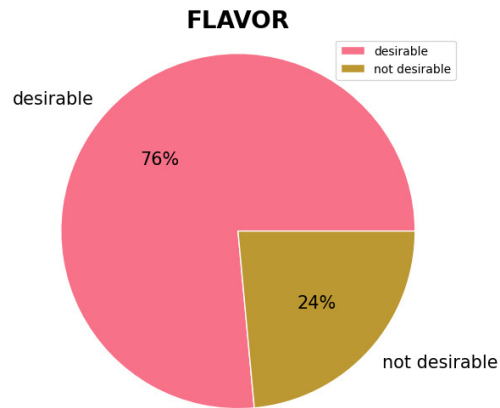
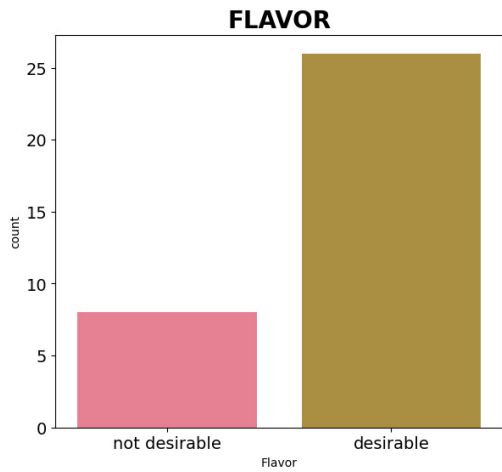
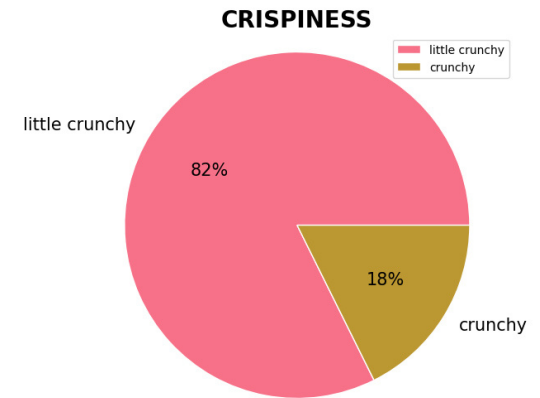
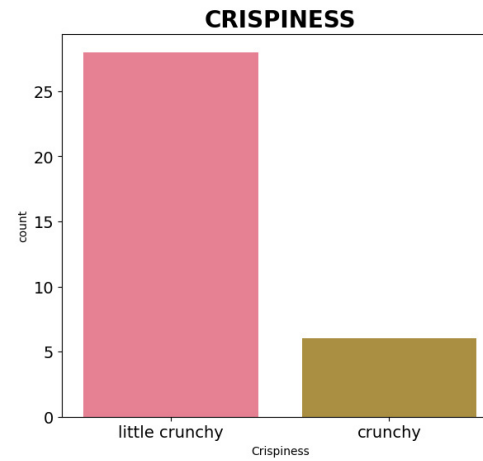


Figure 4: Crispiness of All Formulations



Annex III- Cluster Analysis Results

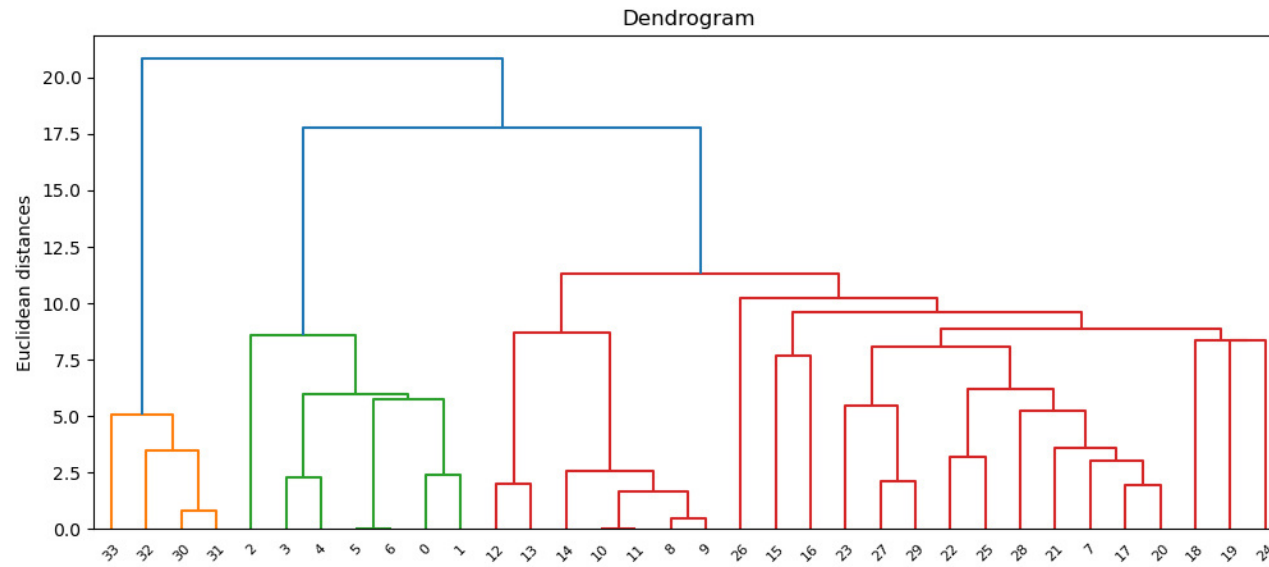
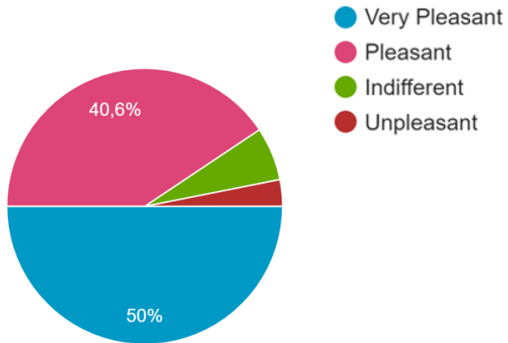


Figure 1: Dendrogram (Number of Clusters in the Dataset)

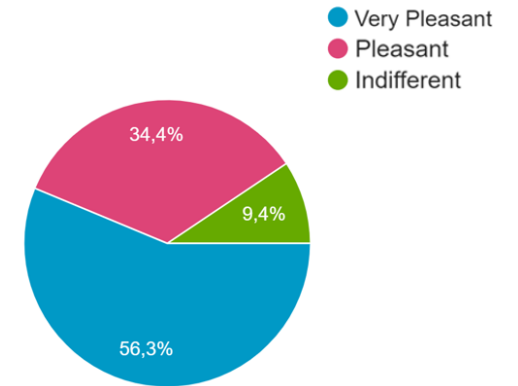
Annex IV - Sensory Analysis

Figure 1 to 5 - Results of the sensory analysis of potential consumers

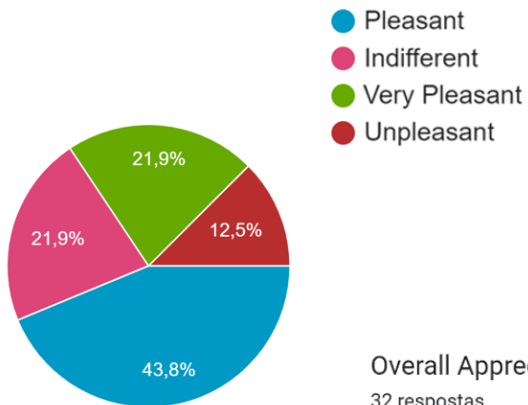
Appearance
32 respostas



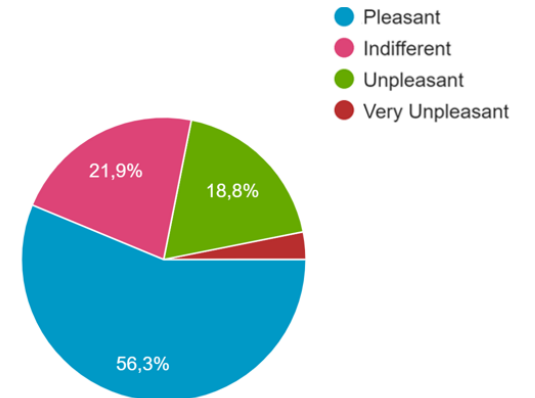
Smell:
32 respostas



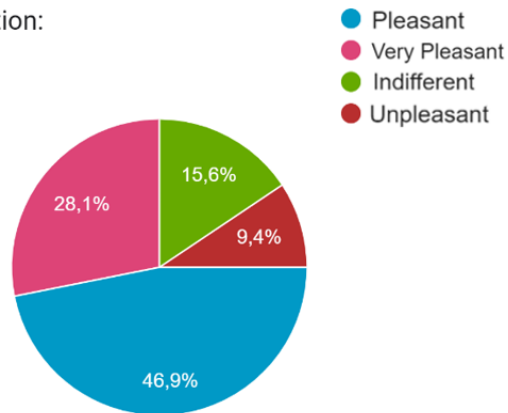
Taste:
32 respostas



Texture:
32 respostas



Overall Appreciation:
32 respostas



Annex V

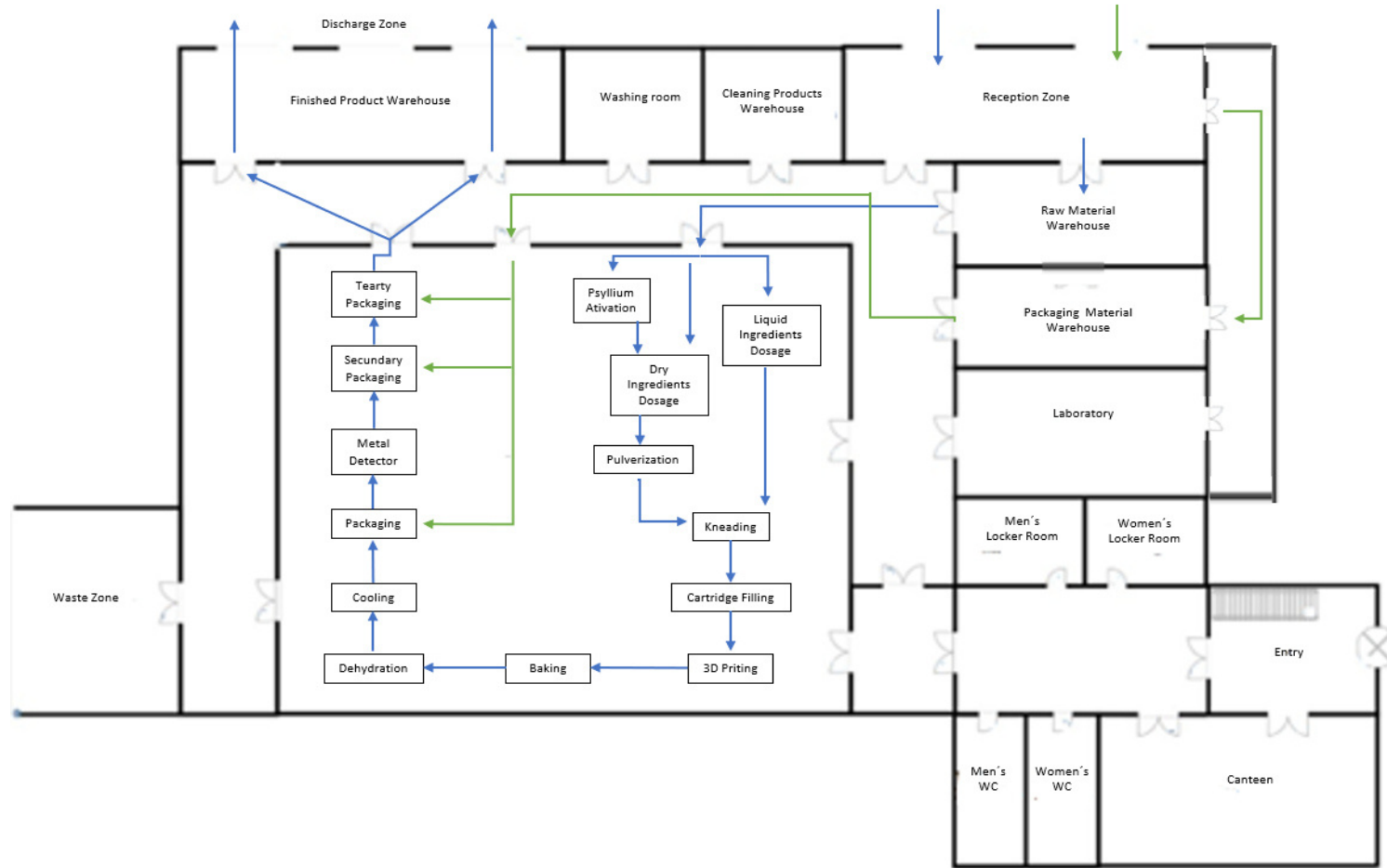


Figure 1- Proposal for production line

Annex VI

Table 1- HACCP

Process	Hazard	Control Parameter	PCC N°	Critical Limit	Monitoring			Corrective Measure	Record
					Method	Frequency	Responsible		
Baking	Time/Temperature Binominal not respected	Time/Temperature Binominal	1	T= 180° C t= 10 min	Time and temperaute measurement	Each batch	Employee qualified and responsible for the operation	Reject the product if necessary. Reprocessing if possible. Maintenance of the equipment	Time and temperature records
Dehydration	Time/Temperature Binominal not respected	Time/Temperature Binominal	2	T= 60° C t= 2 h	Time and temperaute measurement	Each batch	Employee qualified and responsible for the operation	Reject the product if necessary. Reprocessing if possible. Maintenance of the equipment	Time and temperature records
Cooling	Time/Temperature Binominal not respected	Time/Temperature Binominal	3	T= 20° C t= 6 min	Time and temperaute measurement	Each batch	Employee qualified and responsible for the operation	Reject the product if necessary. Reprocessing if possible. Maintenance of the equipment	Time and temperature records
Metal Detector	Physical contamination	presence of foreign bodies	4	Absence	Metal Detector	Each batch	Employee qualified and responsible for the operation	Reject the product if necessary	Metal detection records

Annex VII

Table 2 - Cost of produce one kg of product

Cost of produce one kg of product			
Category (euro/kg)	Year 1	Year 2	Year 3
Packaging	€1.1	€1.1	€1.1
Raw material	€5.2	€5.2	€5.2
Marketing and advertising	€5.1	€3.5	€2.8
Utilities	€3.2	€2.1	€1.6
Cleaning	€0.3	€0.2	€0.1
Fixed	€13.8	€9.2	€6.9
Utensils	€0.4	€0.3	€0.2
Total cost / kg	€29.0	€21.6	€17.9
Sell price	€65.0		
Margin	55%	67%	73%

Table 3 - project's operating expenses, and the gain by sales, per year.

Income Stream				
Item / year	0	1	2	3
Sells	€0	€264,000	€396,000	€528,000
Administrative investment	-€2,182	€0	€0	€0
Dinning room investment	-€734	€0	€0	€0
Equipment investment	-€109,057	€0	€0	€0
Inicial investment	-€111,973	€0	€0	€0
Packaging cost	€0	-€5,136	-€7,704	-€10,272
Raw material cost	€0	-€24,852	-€37,279	-€49,705
Marketing and advertising cost	€0	-€24,247	-€25,459	-€26,672
Utilities cost	€0	-€15,354	-€15,354	-€15,354
Fixed cost	€0	-€66,076	-€66,076	-€66,076
Cleaning cost	€0	-€1,399	-€1,399	-€1,399
Utensils cost	€0	-€2,004	-€2,004	-€2,004
Total cost	€0	-€139,067	-€155,274	-€171,480
Gain for selling	-€111,973	€124,933	€240,726	€356,520
Total opeation cost	-€111,973	-€139,067	-€155,274	-€171,480

Table 4 - Cash flow before financing for spoon-eat

Cash-flow before financing		Cash-flow before financing			
		0	1	2	3
Inflows	Gross productive value (€)	€0	€124,933	€240,726	€356,520
	Othe income	€0	€0	€0	€0
	Residual value (equipments)	€0	€0	€0	€0
	Total incomes	€0	€124,933	€240,726	€356,520
Outflows	Investments	-€111,973	€0	€0	€0
	Operating expenses	€0	-€139,067	-€155,274	-€171,480
	Additional working capital	-€27,813	-€3,241	-€3,241	€34,296
	Total outcomes	-€139,786	-€142,308	-€158,515	-€137,184
Total	Net benefit before financing	-€139,786	-€17,375	€82,212	€219,336

Table 5 - Financial indicators of the cash flow before financing for spoon-eat

NPV	0	1	2	3
Net benefit before financing	-€139,786	-€17,375	€82,212	€219,336
Present value	-€139,786	-€16,548	€74,568	€189,471
Total NPV	€107,705			

IRR	28%
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Benefit-Cost ratio	1.8
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Recovery period	0	1	2	3
Present value	-€139,786	-€16,548	€74,568	€189,471
Recovery period	-€139,786	-€156,334	-€81,766	€107,705