



## Vegan cheese from *Lupinus mutabilis*. A preliminary study.

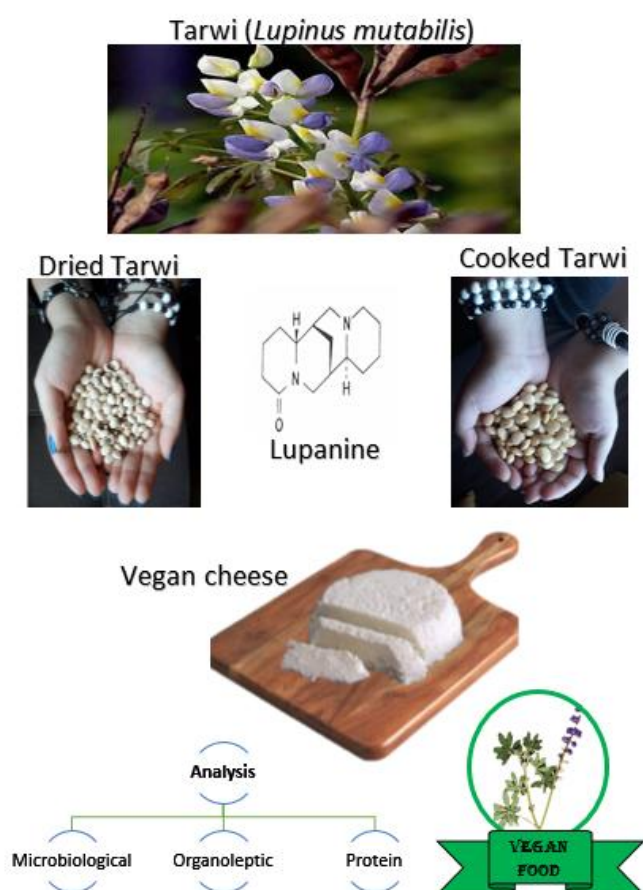
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### Graphical Abstract.



### Abstract.

Vegan cheese alternatives are gaining new interest for the agro-industrial market due to the improving request of animal friendly products. The present research focused a preliminary development of a vegan cheese production based on *Lupinus mutabilis* derivatives. The vegan cheese have been produced removing lupanine. Microbiological analysis, moisture content, protein amount, and organoleptic analysis have been performed respecting several national, and international guidelines. All microbiological data are compliant with international regulations ranges regarding molds, yeasts, and coliforms. Moisture content was 59.15%, and the protein amount 40%. The organoleptic analysis, based on a 5-point hedonic scale, shown a average of 4.3, which reveal a very acceptable results. All these preliminary results showing a promising lupine-based food, which give an interesting vegan cheese alternative.

### Introduction.



*Lupinus mutabilis* is a legume originating in the South American Andes, widely used in countries such as Bolivia, Ecuador, and Peru, where it has had great relevance in gastronomy since pre-Hispanic times. Its high protein content, even higher than soy, allows it to be of interest for human nutrition, especially in the period of physical, and intellectual development of children, since it has calcium, and amino acids in great quantity [1]. *L. mutabilis* has a great nutritional value due to its high protein content, which borders 38.9%, the average fat ranges from 17.1%, and its energy supply is 411 cal / 100g, however, it has alkaloids in the order of 3.5% - 4.2% that do not allow their direct consumption, previously having to carry out a delupinization or debonding process [2].

*L. mutabilis* contains lysine, and leucine, essential amino acids suitable for growing children as well as pregnant, and lactating women. Its protein value is comparable to that of foods of animal origin such as milk, meat, cheese, and eggs [3]. The lipids present in the grain of the twine possess essential fatty acids such as linolenic, and linoleic important for the development of the central nervous system, immune function, and body growth, these have the property of increasing HDL cholesterol (high-density lipoprotein), and reducing LDL cholesterol (low-density lipoprotein), triglycerides, and insulin resistance, helping to reduce the risk of cardiovascular disease [4].

The main scope of the present research was to investigate the formulation of a vegan cheese based on *L. mutabilis* derivatives. The search has been focused on an innovative food product rich in nutrients, and with antioxidant properties, which is presented as an alternative for a vegan audience.

### Materials and Methods.

*L. Mutabilis* seeds used in the production of the vegan cheese belongs to the “INIAP 451 Guaranguito variety”, which was subjected to a classification process, selecting only the whole grains without any alteration.

*L. Mutabilis* seeds have been hydrated in demineralized water (3/1 ratio) at room temperature for 16 hours, then have been drained, and cooked in a 2 to 1 ratio (water-grain) at 100 ° C for 30 minutes. In order to remove the lupinine, a bitter alkaloid that must be avoided into the final product, *L. Mutabilis* seeds have been treated by ozonation for 10 minutes, and after the seeds have been washed in water for seven days, replacing the water every 48 hours. In this last step, a water-grain ratio was 1 to 10.

*L. Mutabilis* seeds free of lupanine was grounded obtaining a lumpy, and soft consistency, which was kneaded with sodium chloride in a proportion of 1g x 1000g (salt-grain), and then pressed, and molded. Molds, and yeasts determination have been applied according to the [5], for total coliforms was used the [6], the moisture determination by the Methel [7], and the protein determination by the [8]. The assay concerning the crude protein in meat were made in the Bromatology Laboratory of the Bolívar State University.

Organoleptic assay was performed using sensory tests with a panel of 15 trained tasters who used a 5-point hedonic scale, with 5 being the best, and 1 the lowest.

### Results and Discussion.



As reported in the Table 1, the amount of molds allowed in the [5] is up to 50 CFU/g, the same standard indicates that the maximum of yeasts must not exceed 100 CFU/g, as it can be seen the results for these two parameters are within the permitted limits, according to the [6], there should be no total coliforms in the product, by contrasting the results against the standard, the microbiological requirements are met.

Table 1. Microbiological analysis on vegan cheese.

Sample	Assay	Result (CFU/g)	Reference	Range (CFU/g)
R1	Mold	7	[5]	1 to 50
R2	Mold	8	[5]	1 to 50
R1	Yeast	9	[5]	maximum 100
R2	Yeast	5	[5]	maximum 100
R1	Total coliforms	0	[6]	0
R2	Total coliforms	0	[6]	0

The average of the 4 replicates of the humidity analysis was 59.15% (Table 2), which is comparable with the results obtained by Diaz Galindo, *et al.* [9] which are between 55, and 66% for fresh cheeses, this data is corroborated by the Argentine Ministry of Production, and Labor, which in its regulation says that humidity must exceed 55%. However, Chacón-Villalobos and Pineda-Castro [10] states that this property must be in the order of 56%, when comparing the results of this study with similar works done on fresh cheeses, it is stated that the product made from *L. mutabilis* meets the required humidity requirements [10].

Table 2. Moisture analysis on vegan cheese.

Sample	Result (%)
R1	59.31
R2	59.03
R3	59.32
R4	58.93

The results concerning the protein amount of vegan cheese have been reported on Table 3. Castañeda, Manrique, Ibáñez, Gamarra, Galan and Quispe [2], mentioned that the protein content in *L. mutabilis* is around 40% of dry extract, the average of the experimental results for fresh cheese made from *L. mutabilis* base using the Guaranguito variety from INIAP is 55.01%, this value is very close to the data declared by the [11] which is 54%.

Table 3. Protein analysis on vegan cheese.

Sample	Result
R1	55.03
R2	54.98
R3	54.92
R4	55.10



Finally, the result concerning the organoleptic analysis are available at Table 4. The final color of the vegan cheese is white with a slight yellowish hue which, according to the tasting panel, is good, since it reaches an average of 4 on the hedonic scale used in the study, the smell, and taste of the product had an average of 4.3 indicating that the aroma obtained a good acceptance among the evaluators, regarding the texture it is slightly hard, and lumpy, typical of the kneading process to which it was subjected, bordering a rating of 4 that is very acceptable.

Table 4. Organoleptic analysis on vegan cheese.

Parameter	Average
Color	4.42
Perfume	4.31
Taste	4.32
Texture	4.23

### Conclusions.

vegan cheese obtained by *L. mutabilis* complies with microbiological regulations regarding molds, yeasts, and coliforms, which makes it a safe food.

The percentage of moisture present fits within the type of cheese proposed, in addition, it is rich in protein, which is appropriate for a consumer in the process of development. The organoleptic characteristics of this lupine-based food give it an additional incentive for its consumption.

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