Formulation of a Functional Lactic Drink Enriched with Different Proportions of Quinoa (Chenopodium Quinoa)

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Abstract—The present research work is to propose, formulate an optimal functional drink and reduce the impact generated by the cheese industries. Different formulations enriched with quinoa were evaluated and thus be able to characterize it as sensorial acceptable. The Taguchi methodology was used in the formulation process, which allowed us to work with three control factors: serum (LC), water (AG), and quinoa flour (HQ), with two levels of work and four experimental runs. The four formulations were F1 (LC (50%), AG (30%) and HQ (5%)), F2 (LC (50%), AG (40%) and HQ (10%)); F3 (LC (60%), AG (30%) and HQ (10%)) and F4 (LC (60%), AG (40%) and HQ (5%)). A sensory acceptability (AS) analysis determined by taste, color, and the smell was performed. The best formulation was F3 with an AS (4.46) equivalent to the "moderately similar" signal/noise ratio (12,987).

Index Terms—Functional lactic, proportions of quinoa, lactic drink

I. Introduction

Milk is the raw material with which cheese is made. Cheese production requires a large amount of milk; to obtain a kilogram of cheese, approximately 10 liters of milk are needed, and 9 liters of whey are generated as a byproduct. Whey is the liquid residue that is obtained mainly after the separation of the curd in cheese making. On average, it contains more than half of the solids present in the original milk, including about 20% of the proteins, most of the lactose minerals, and soluble vitamins.

According to an FAO work, whey, a liquid residue from the manufacture of cheese and casein, is one of the largest reserves of food proteins still outside human consumption channels. Paradoxically, even today, a large proportion of the entire litters generated by the day continue to be wasted. Traditionally, serum was considered an undesirable element, of little interest and high cost of disposal. In the concentration of milk during cheese processing [1], whey is released, which corresponds to about 83% of the volume of milk used as raw material, which is exuded from inside the cheese curd. It contains about 50% of the concentration of milk solids and particularly its serum proteins, which are of excellent quality because they provide essential amino acids and have a high absorption coefficient, it is considered a high-value product nutritious as it is discussed in [2].

Physicochemical tests were carried out on milk and cheese and texture profile analysis (TPA) on cheese. The results indicate that the incorporation of whey protein concentrates into cheese increases yield [3]. Functional drinks are characterized by offering the customer a beneficial and nutritious product for health. The development of the profile of available drinks should also consider the preservation of valuable compounds or properties. Consumers are looking for practical and convenient foods that save time and effort. In the elaboration of available drinks, it is necessary to characterize the ingredients to be used. It is needed to find the optimal mixture of components that generate a new product whose formulation offers functional product characteristics with high nutritional value). Whey, a material that is usually discarded by the dairy industry is whey is rich in phosphorus. It is also more abundant in calcium and lactic acid. It is estimated that 10 liters of cow's milk can produce 1 to 2 kg of cheese and an average of 8 to 9 kg of whey, representing about 85-90% of the volume of milk, which contains around 55% of its nutrients. Water is the component that allows the drink to generate the characteristic of freshness. Quinoa is an Andean cereal. Protein content can range in range from 7.47% to 22.08%. Quinoa is a natural product of the Andean region. Sugar is an ingredient whose attribution to the drink improves taste and allows better sensory acceptance. However, it must be taken into account that sugary beverages do not provide any nutritional benefit, as is found in [4].

This paper identified technological trends in the production of sweeteners syrup and the use of whey through a patent review in the databases of Espacenet, Google Patent Search, and the Superintendence of Industry and Commerce of Colombia SIC. Two hundred twenty-six documents were found, 119 international patents and 107 applications were

Manuscript received January 12, 2021; revised May 21, 2021.

doi: 10.18178/ijfe.7.1.12-16

registered with the SIC. Only three papers deal with the production of sweetener syrup; the rest are mainly oriented to the extraction of the proteins contained in the whey and its application in different fields..[5]

The fact of obtaining a mathematical model is significant because you can get many answers just by studying some levels of work through discrete simulation and the design of experiments. A mathematical model with a function as in formula (1) that describes sensory acceptability was used [6]

$$ceptability = b_o + b_1x_1 + b_2x_2 + b_{11}x^2{}_1 + b_{22}x^2{}_2 + b_{12}x_1x_2 \quad (1)$$

$$b_o = calculated\ coefficient\ for\ the\ surface\ and\ response\ methodology$$
$$x_i\ y\ x_2 = ingredient\ levels$$

To calculate the sample size, you have the following formulation:

$$n = \frac{Npq}{(N-1)D + pq} \quad (2)$$

$$p = 1 - q \qquad D = \frac{B^2}{4}$$

N = population size
p = probability of success
q = probability of failure
D = precision (maximum permissible error in terms of proportion)
B = magnitude estimation error

II. Method and Materials

The research, the procedures to elaborate a functional drink of Lacto-serum enriched with quinoa are detailed to characterize it sensually acceptable. The design is an experimental transactional type evaluated on time. It will consist of an explanatory level where the causes that cause the problem are sought based on independent and correlational variables [7]

A. Instruments for Data Collection and Data Processing

The following programs will be used for data processing: Minitab version 16, Microsoft Office Excel 2013, and IBM SPSS Statistics.

B. Supplies, Materials, and Equipment

The following ingredients are required: whey, water, quinoa flour, sugar, additives (citric acid, potassium sorbate, and others). Moreover, scales, test tubes, thermometers, Erlenmeyer glasses, spoons, bowls, and containers will be used.

C. Experimental Design

The experimental design of a single utter randomized factor was applied used in the food industry, with three replicas for each treatment, to determine the best milk beverage mix [8]

The raw materials used for the manufacture of the dairy beverage are quinoa, milk, and whey. Four formulations were made containing different percentages of quinoa.

D. Information Processing and Analysis

The analysis of the information received was performed; that is to say, ablution of incorrect information: incompatible, inconclusive, not pertinent, since when making cupping it, is necessary to be aware that all the information that is collected is helpful for the investigation, the indispensable data for the research should have been clear taking the study variables were taken into account, since regarding these variables, the necessary information that would allow establishing the best beverage mix had to be collected. [9]

III. Experimental Design

Acceptability through the Taguchi Method: Three independent variables were identified: whey (LC), water (AG), quinoa flour (HQ), two levels of work will be presented Table I), and the dependent variable is formulation (F). The indicators to be analyzed are sensory acceptance (AS), signal to noise (S/N), and delta.

TABLE I. Levels Considered in the Taguchi Experimental Design

Control factors	Levels	
	1	2
Whey	50 %	60 %
Water	30 %	40 %
Quinoa Flour	5 %	10 %

** 1 = minimum; 2 = maximum*

Table I shows the percentage composition of the mixes and the levels

TABLE II. Experimental Formulations with Taguchi Design

Design point	LC	AG	HQ
F1	1	1	1
F2	1	2	2
F3	2	1	2
F4	2	2	1

In Table II, four experimental formulations of the functional drink of Lacto-serum fortified with quinoa were obtained.

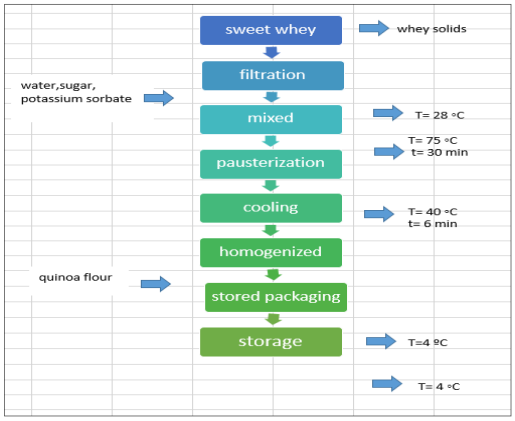

Figure 1. Process flow diagram

In Fig. 1 shows the sequence of the production process during its elaboration of the fortified beverage.

IV. Results

A. Population Sample Determination

The following equation determined the sample size of the student population of the School of Agricultural Engineering: With 130 students from the total population, B (0.05), p (50%), and q (50%).

$$n = \frac{Npq}{(N-1)D+pq} \quad (3)$$

N = 162 *n = 61 people to survey*

where
N = population size
Z = confidence level
P = probability of success, or expected proportion
Q = probability of failure
D = precision (Maximum permissible error in terms of proportion)

B. Statistical Analysis

The results of the evaluation of sensory attributes and acceptability are presented in the figure. It is evidenced that the treatment with higher acceptability was F3; in this case, the concentrations of the three components of the drink in this treatment give an appearance and sensory stimuli similar to a whole UHT milk, hypothesis argued by the tasters (untrained panel) [10].

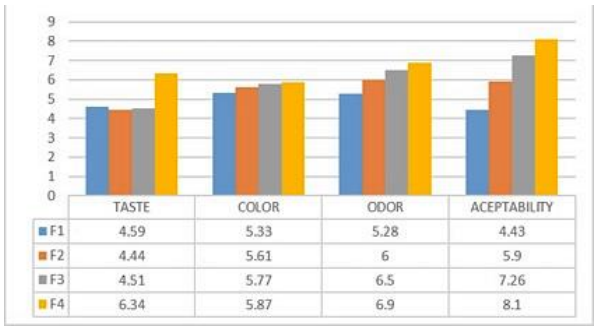

Figure 2. Summary of the sensory test.

In Fig. 2 shows demonstrates that the incorporation of quinoa, its balance with whey and milk in mixture three, considerably improves sensory attributes concerning white, making this the best mix.

TABLE III. Sensory Test Data

Sample	Taste	Color	Odor	Aceptability
F1	4,59	5,33	5,28	4,43
F2	4,44	5,61	6,00	5,90
F3	4,51	5,77	6,50	7,26
F4	6,34	5,87	6,90	8,10

In Table III shows the behavior of the sensory test data of the samples

C. Sensory Analysis of the 4 Samples of Milk Drink

The evaluation establishes that between treatments and tasters, there is a significant difference ($P \geq 0.05$) for all evaluation parameters, these differences depended on the criteria of the tasters, which shows that the different proportions in the formulations of each treatment cause structural and sensory differences in the drink, which the panel could easily detect and caused the sensory mean between the samples and the tasters to be similar for each parameter analyzed [10].

TABLE IV. Reason for the Variance

Sample	Taste	Color	Odor	Aceptability
F1	4,59	5,33	5,28	4,43
F2	4,44	5,61	6,00	5,90
F3	4,51	5,77	6,50	7,26
F4	6,34	5,87	6,90	8,10

In Table IV shows the behavior of the reason the variance of the samples about taste, color, odor, and acceptability

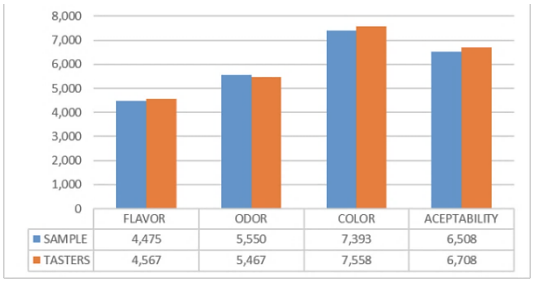

Figure 3. Reason for the variance.

In Fig. 3 shows the behavior of the four levels, in which we can observe the variation

D. Optimal Formulation

Table IV shows that the best combination of independent variables corresponded to F3 with an average AS score equal to 4.46 equivalent of a "Moderately Like" rating and an S / R-value of 12,987 (higher is better).

The Taguchi methodology was used in the formulation process, which allowed us to work with three control factors: whey (LC), water (AG), and quinoa flour (HQ), with two levels of work and four experimental runs. The four formulations were F1 (LC (50%), AG (30%) and HQ (5%)), F2 (LC (50%), AG (40%) and HQ (10%)); F3 (LC (60%), AG (30%) and HQ (10%)) and F4 (LC (60%), AG (40%) and HQ (5%)). A sensory acceptability (AS) analysis determined by taste, color, and the smell was performed. The best formulation was F3 with an AS (4.46) equivalent to a "moderately liked" Signal / Noise ratio (12,987) [11].

E. Ready Formulations

In Fig. 4 shows the four bottles of the final products with the different variance

Figure 4. Final product.

TABLE V. AVERAGE AS AND S/R VALUES OF EXPERIMENTAL FORMULATIONS

Sample	Taste	Color	Odor	Aceptability
F1	4,59	5,33	5,28	4,43
F2	4,44	5,61	6,00	5,90
F3	4,51	5,77	6,50	7,26
F4	6,34	5,87	6,90	8,10

In Table V shows the average of one repetition; work levels: 1 = lower and 2 = higher

V. CONCLUSION

The optimal formulation for making a functional drink of Lacto-serum fortified with quinoa was determined by 30% water, 60% whey, and 10% quinoa flour [12].

The ingredients with the most significant influence in the elaboration of the functional drink of Lacto-serum enriched with quinoa depending on the sensory acceptability determined by the S /R were water (30%) and whey (60%).

The addition of quinoa flour if it affects the sensory acceptability of the product according to the S /, R determines that the higher the amount of quinoa flour shows lower the acceptability of the product [13].

VI. DISCUSSION

The formulations 15%: 7.5%, 15%: 10%, and 11.5%: 10% were preferred by consumers, which is related to a sweeter and more intense flavor of this formulation. However, in the present study, the higher acceptability of the product (4.46) was determined by applying a 5-point hedonic test, when 60% of whey is used, which qualifies it as "moderately liked."

CONFLICT OF INTERESTS

This research was carried out as a contribution to the knowledge, society, and academic purposes contribute to the understanding of the development of new perfume essences, "The authors declare that we have no conflicts of interest."

AUTHOR CONTRIBUTIONS

A carried out the research design; AB select the materials to experience, AC carried out the creation of the CD Experimentation development and data analysis. We carried out the exploratory field study, the authors' contribution is reflected in all the research approved in its final version.

REFERENCES

[1] S. Strite and H. Morkoc, *J. Vac. Sci. Technol.*, B 10 1237, 1992

[2] S. Nakamura, M. Senoh, S. Nagahama, N. Iwase, T. Yamada, T. Matsushita, H. Kiyoku, and Y. Sugimoto, *Japan. J. Appl. Phys.* 35 L74, 1996

[3] S. M. Sze, *Earth and Environmental Science of Semiconductor Devices*, New York: Wiley–Interscience, 1969

[4] L. I. Dorman, *Variations of Galactic Cosmic Rays*, Moscow: Moscow State University Press, 1975, p. 103

[5] R. Caplar and P. Kulisic, *Proc. Int. Conf. on Nuclear Earth and Environmental Science (Munich)*, Amsterdam: North-Holland/American Elsevier, 1973, vol. 1, p. 517

[6] A. Szytula and J. Leciejewicz, *Handbook on the Earth and Environmental Science and Chemistry of Rare Earths*, K. A. Gschneidner Jr and. L. Erwin, Eds., Amsterdam: Elsevier, 1989, vol. 12, p 133

[7] T. Kuhn, "Density matrix theory of coherent ultrafast dynamics," in *Theory of Transport Properties of Semiconductor Nanostructures (Electronic Materials)* E. Schöll, Ed., London: Chapman and Hall, 1998, vol. 4, pp. 173–214

[8] J. P. Conti, M. C. Ceriani, M. A. Juliarena, and E. N. Esteban, "Protein and peptide profile of a fluid base for functional drinks obtained by fermentation of Lactoserum," *Technological Information*, vol. 23, no. 2, p. 62, 2012

[9] M. M. Arteaga, L. H. C. Molina, P. C. Manuel, *et al.* "Characterization of chanco cheese enriched with whey powder, *Rev Chil Nutr*, vol. 36, no. 1, pp. 53-62, March 2009

[10] D. Acevedo, J. D. C. Jaimes, and C. R. Espitia, "Effect of the addition of lactoserum to kneaded cotija cheese," *Technological Information*, vol. 26, no. 2, pp. 11-16, 2015

[11] J. S. M. Jiménez, "Application of an emulsifying blend in the development of a dairy beverage through the UHT process, with partial replacement of milk by sweet whey," *Technological Information*, vol. 26, p. 33-50, 2015

[12] J. A. Gómez-Soto, O. J. Sánchez-Toro, and X. Benavides-Salazar, "Patent analysis as an approach to the conceptual design of the process for obtaining whey syrup," *Rev. Investig. Desarro. Innov.*, vol. 7, no. 2, pp. 331-353, 2017.

[13] R. Blanquicet, C. Flórez, Y. González, E. Meza, and J. Rodríguez, "Synthesis and properties of films based on chitosan / lactoserum," *Polymers: Science and Technology*, vol. 25, no. 1, pp. 58-69, 2015.

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used

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