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ORIGINAL ARTICLE

Behavior of physical, chemical, and microbiological attributes in ketchup during storage

Comportamiento de atributos físicos, químicos y microbiológicos en catsup durante su almacenamiento

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Abstract In some cases, after the production of ketchup, electrical interruptions occurred, forcing the product to be bottled at temperatures different from the established standards, which affected its quality. This study aimed to evaluate the changes in the ketchup produced at the Elpidio Aguilar factory during one month of storage at room temperature. The products met the quality specifications for acidity, showing an increase in this parameter over time. The ketchup bottled on the same day of production had an acidity of 1.41%, which was lower than that of the product bottled 24 hours later (1.47%). The sodium chloride content remained within the established limits (1.81 and 1.75%, respectively). The soluble solids contents complied with the standard (25.0-28.0 ºBrix). Furthermore, microbiological analyses revealed the absence of fungi and yeasts, demonstrating that the factory adhered to good manufacturing practices to eliminate microbial contamination.

Keywords ketchup, physical attributes, chemical attributes, microbiological attributes, storage.

Resumen En algunas ocasiones, luego de la elaboración del catsup, se produjeron interrupciones eléctricas que obligaron a envasar el producto a temperaturas diferentes a las normalizadas, lo que afectó su calidad. Este trabajo tuvo como objetivo evaluar los cambios en el catsup elaborado en la fábrica Elpidio Aguilar durante un mes de almacenamiento a temperatura ambiente. Los productos cumplieron con las especificaciones de calidad para la acidez mostrando un incremento en este parámetro a lo largo del tiempo. El catsup envasado el mismo día de la elaboración presentó una acidez de 1,41 %, menor que la del producto envasado 24 horas después (1,47 %). El contenido de cloruro de sodio se mantuvo dentro de los límites establecidos (1,81 y 1,75 %, respectivamente). Los contenidos de sólidos solubles cumplieron con la norma (25,0-28,0 ºBrix). Además, los análisis microbiológicos revelaron ausencia de hongos y levaduras, lo que demostró que la fábrica cumplió con las buenas prácticas de producción para eliminar la contaminación microbiológica.

Palabras clave catsup, atributos físicos, atributos químicos, atributos microbiológicos, almacenamiento.

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PUBLIS EDITORIAL

Introduction

The Elpidio Aguilar Rodríguez Factory in Havana, Cuba, has been producing various products for the country for many years, including Neapolitan sauce, concentrated tomato, dry seasoning, fried potato, fried sweet potato, mustard, and ketchup.

Ketchup is a very popular sauce, typically made with ripe tomatoes. The basic ingredients in modern ketchup include tomatoes, vinegar, sugar, salt, black pepper, cloves, and cinnamon, as well as onions, celery, and other vegetables.

Storage studies are fundamental in the development of new products, especially when there are variations in the production of existing ones or the substitution or change of specifications for any raw material or material. The determination of the shelf life of a food product may seem straightforward; however, estimating the product's durability presents multiple challenges. These include the diversity of spoilage pathways, the intrinsic stability of the products, the different types of packaging, the technologies used in their production, and the storage conditions.

In our country, ketchup is highly accepted among consumers and has become a commonly used product in home cooking. These reasons indicate that shelf life must be known by both domestic and foreign consumers, as well as by producers and exporters.

In this regard, this study focused on evaluating the physical, chemical, and microbiological attributes of ketchup produced at the Elpidio Aguilar factory and stored at room temperature for one month.

Materials and methods

The ketchup was produced at the Elpidio Aguilar Rodríguez Factory in Havana, Cuba. Various raw materials were used, with concentrated tomato as the main ingredient. Additionally, modified starch was incorporated as a thickener to achieve the product's characteristic viscosity, vinegar was added to develop flavor, fine salt served as a preservative and flavor enhancer, refined sugar contributed to the taste profile, sodium benzoate, and potassium sorbate were used as preservatives, citric acid acted as an antioxidant to minimize oxidative reactions, and sweet paprika provided aroma and color. A specific ketchup seasoning was also added to enrich the flavor.

The production process included several stages: first, the ingredients were mixed, followed by cooking to ensure proper integration and flavor development. The product characteristics were then adjusted according to the desired specifications. The ketchup was filled into containers, sealed to ensure preservation, and appropriately labeled and capped. Finally, shrink-wrapping was performed for packaging, and the product was marked before storage as a finished product.

Evaluations of the physical and chemical quality attributes were carried out at the beginning and end of each storage period. Acidity, pH, sodium chloride, and soluble solids were determined according to established methods. Additionally, microbiological analyses were conducted for the total count of fungi and yeasts at the beginning and end of each storage period. The data were analyzed using STATISTICA software, calculating means and exporting results to Excel, where they were graphically represented for easier interpretation.

Results and discussion

Acidity is one of the most relevant parameters that must be controlled in foods, both in the raw material and in the production process and final product. Reviewing food quality control standards, it is observed that acidity determination is applied to a wide variety of products due to its direct impact on organoleptic characteristics, as well as on technological and preservation properties.

In many cases, acidity is associated with degradative processes in foods. An unexpected increase in acidity may indicate possible microbial contamination, as certain microorganisms, such as lactic acid bacteria and yeasts, produce acids during their metabolism. Alternatively, changes in acidity may result from inadequate product formulation.

Therefore, acidity determination presents itself as a valuable tool for monitoring food spoilage over time, supporting the existence of quality control standards that regulate acceptable ranges for this parameter in each type of product. The obtained acidity data were graphed for better understanding and further analysis (Figure 1).

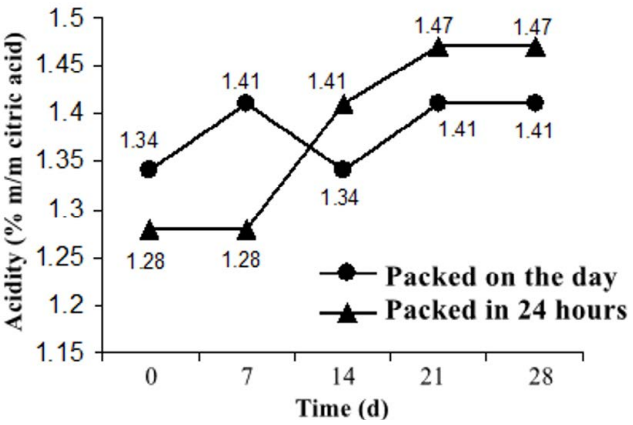

Figure 1. Behavior of acidity in the ketchup during storage.

The initial acidity of the product, and consequently its pH, are influenced by the acidity characteristics of the raw materials used in its production, primarily by the tomato concentrate and the acetic acid present in the vinegar.

The results of pH and acidity measurements obtained in the ketchup evaluations are presented in Table 1.

Table 1. Results of pH for the treatments

Treatment	Time (days)	pH
Ketchup packaged the same day it is made	0	3.70
	7	3.73
	14	3.75
	21	3.78
	28	3.86
Ketchup packaged 24 hours after preparation	0	3.77
	7	3.77
	14	3.87
	21	3.80
	28	3.79

The products displayed acidity values during storage that were in accordance with those established in NEIAL 1645-209: 2004 (1.3-2.3%) and those reported by some authors, who indicated values of 1.5-2.0% (Zumbado, 2005), as well as a pH lower than 4.2 (MS 8.28, 1978). However, an increase in acidity was observed over time, with the product packaged on the same day of production showing lower acidity compared to the product packaged 24 hours after its production.

The determination of sodium chloride content constituted one of the most important chemical analyses conducted on foods as part of quality control. The significance of this determination arose from the multiple functions that sodium chloride, or common salt, performs in foods, making it one of the most widely used food additives in the food industry.

Sodium chloride has a decisive influence on the organoleptic characteristics of foods, especially on flavor, as it is one of the basic tastes (salty) and also contributes to enhancing the other flavors in foods, thereby improving their palatability (Zumbado, 2005). Another crucial function of sodium chloride in foods is its ability to promote their preservation (Zumbado, 2005). Table 2 presents the results of sodium chloride determinations obtained in the ketchup evaluations.

Table 2. Results of sodium chloride for the treatments

Treatment	Time (days)	NaCl (%)
Ketchup packaged the same day it is made	0	1.79
	7	1.75
	14	1.79
	21	1.77
	28	1.81
Ketchup packaged 24 hours after preparation	0	1.77
	7	1.75
	14	1.75
	21	1.75
	28	1.75

The sodium chloride content of the product was attributed to the addition of fine salt in the formulation and to the contribution from the tomato concentrate used as raw materials. Both treatments presented sodium chloride values that corresponded to those expressed in NEIAL 1645-209 (2004) (1.3-2.0%), as well as to the values reported by some authors, which ranged from 1.3 to 1.9% (Zumbado, 2005). Hankin (1986) found sodium chloride values in ketchup exceeded 3.54%, which was due to differences in the formulation of the wide range of similar products marketed worldwide.

Figure 2 shows the results obtained from the refractometric measurement of the soluble solids content present in the product.

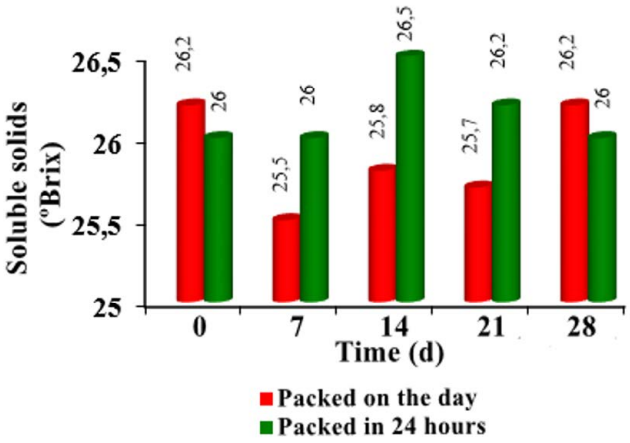

Figure 2. Behavior of the soluble solids content in the ketchup during storage.

The soluble solids content obtained for the product was determined by the raw materials used in its manufacturing, which contributed soluble solids, such as refined sugar and tomato concentrate. The °Brix values of both treatments during storage complied with those expressed in NEIAL 1645-209 (2004) (25.0-28.0%).

The counts referred to fragments of fungal mycelium that had developed in the food or to colonies on plates of an appropriate medium. In the first case, this could be used to assess the quality of the raw materials used in the production of a product, usually of plant origin; the presence of inhibitory substances and even the lack of viability of the fungus were not significant. In contrast, when the aim was to determine the number of microorganisms present, it was essential to perform a viable count to estimate the level of contamination as an indicator of poor hygiene practices (Calizaya et al., 2010).

As soil constitutes the largest reservoir of fungi, its contact with food easily translated into an increase in the microbial load. The microbiological analyses for counting fungi and

yeasts performed on the product during storage were negative, demonstrating that the factory adhered to good manufacturing practices to minimize and, in this case, eliminate any microbiological contamination that could invalidate the product's marketability.

Conclusions

During storage, the products met the quality specifications for acidity, which showed an increase over time. The product packaged on the same day of its preparation had a lower acidity compared to the one packaged 24 hours later. The sodium chloride content, attributed to the added fine salt and the tomato concentrate, also remained within the established parameters. The soluble solids, determined by refined sugar and tomato concentrate, complied with quality standards. Furthermore, the microbiological analyses for counting fungi and yeasts were negative, demonstrating adherence to good manufacturing practices in the factory, ensuring the minimization and elimination of any microbiological contamination that could affect the product's marketability.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Author contributions

Olga González, Rosa E. Sánchez and Yenisé Elledías: Conceptualization, data curation, formal analysis, investigation, methodology, supervision, validation, visualization, drafting the original manuscript and writing, review, and editing.

Data availability statement

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

Statement on the use of AI

The authors acknowledge the use of generative AI and AI-assisted technologies to improve the readability and clarity of the article.

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