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ORIGINAL ARTICLE

Quality of sandwiches prepared at the Havana Gastronomy Basic Unit of CubaCatering S.A.

Calidad de sándwiches elaborados en la Unidad Básica de Gastronomía Habana de CubaCatering S.A.

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Abstract The objective of this study was to evaluate the changes in the ham and cheese sandwich and the assorted sandwich during refrigerated storage. The work was conducted at the Havana Gastronomy Basic Unit of CubaCatering S.A., with determinations made in the laboratories of the Pharmacy and Food Institute, analyzing data from raw materials and finished products from 2006 to 2008. Two experimental batches were carried out, randomly taking 9 units of each product, which were stored between 4 and 6 ºC for subsequent analysis. Physical-chemical analyses (pH and moisture), microbiological analyses (count of aerobic mesophilic microorganisms, total and fecal coliforms, fungi, and yeasts), and sensory evaluations were performed on both products. The results showed minimal variations in pH and moisture values at 48 hours, although the total coliform counts were elevated, especially in Gouda cheese, with no fecal coliforms detected. A descriptive sheet for the sandwiches was created, which will facilitate future sensory evaluations. The ham and cheese sandwich showed greater variations in sensory quality, with defects in appearance being the most significant in the results.

Keywords ham and cheese sandwich, physical-chemical analysis, microbiological analysis, food hygiene, sensory quality.

Resumen El objetivo de este trabajo fue evaluar los cambios en el sándwich de jamón y queso y el sándwich surtido durante el almacenamiento refrigerado. Se realizó en la UEB Gastronomía Habana de Cubacatering S.A., con determinaciones en los laboratorios del Instituto de Farmacia y Alimentos, analizando datos de materias primas y productos terminados desde 2006 hasta 2008. Se llevaron a cabo dos lotes experimentales, tomando aleatoriamente 9 unidades de cada producto, las cuales se almacenaron entre 4 y 6 ºC para análisis posteriores. Se realizaron análisis físico-químicos (pH y humedad), microbiológicos (conteo de microorganismos mesófilos aerobios, coliformes totales y fecales, hongos y levaduras) y sensoriales en ambos productos. Los resultados mostraron variaciones mínimas en los valores de pH y humedad a las 48 horas, aunque los conteos de coliformes totales fueron elevados, especialmente en el queso Gouda, sin encontrar coliformes fecales. Se elaboró una ficha descriptiva de los sándwiches, que facilitará futuras evaluaciones sensoriales. El sándwich de jamón y queso presentó mayores variaciones en calidad sensorial, con defectos en la apariencia siendo los más significativos en los resultados.

Palabras clave sándwich de jamón y queso, análisis físico-químico, análisis microbiológico, higiene alimentaria, calidad sensorial.

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PUBLIS EDITORIAL

Introduction

Postmodern life has generated, among many other socio-economic consequences, profound changes in eating habits. This situation, combined with limited available time, has led to an increase in the consumption of ready-made fast foods that do not require utensils, such as sandwiches. These products, which can contain ingredients like cooked ham, cheese, and mayonnaise, have been associated with foodborne illnesses (FBIs), especially in large cities (Alkerwi et al., 2015).

Fresh and ready-to-eat sandwiches are typically packaged in expanded polystyrene trays covered with polyvinyl chloride films, which provide them with a shelf life of only 72 hours under refrigeration, limiting their distribution. The monitoring and control of food safety must encompass all stages of manufacturing, storage, and distribution, as each stage can be a source of contamination (Fung et al., 2018).

The safety of the product depends on factors such as its pH, aw, and microbiological quality, but its success lies in the synergistic combination of all protective barriers (Carrascosa et al., 2021), with strict refrigeration control being a crucial barrier against microbial growth. Moreover, the hygiene of raw materials and initial microbiological control are essential (Tropea, 2022).

The preparation of sandwiches involves constant handling, which, if not performed under hygienic conditions, can increase the microbial load and reduce product quality, affecting its sensory, nutritional, biological properties, and shelf life (Risk Assessment Studies Report No. 68, 2022).

Handlers must maintain strict personal hygiene, wear appropriate protective clothing, and be aware of their responsibility to ensure maximum asepsis at all times (Pakdel et al., 2023). During storage, foods are subject to spoilage reactions caused by internal factors, such as moisture, pH, acidity, and external factors, including relative humidity, temperature, oxygen, and light (Karanth et al., 2023). The objective was to evaluate the changes in ham and cheese sandwiches and assorted sandwiches, during refrigerated storage.

Materials and methods

The study was conducted in the cold area of the Havana Gastronomy Basic Unit of CubaCatering S.A., on the production line of ham and cheese sandwiches and assorted sandwiches. The determinations were carried out in the laboratories of the Institute of Pharmacy and Food, where the results obtained between 2006 and 2008 on raw materials and finished products were analyzed, based on archived documents from the Quality Control Department. The preparation of the sandwiches consisted of adding the filling to the bread, which was then shrink-wrapped and packaged using a Form/Fill/Seal machine. The products were individually wrapped with Vitafilm, identified with a label indicating the production date, and packaged in nylon bags. At the end of production, the quality, weight, and quantity of units were verified, along with the yield of raw materials, and the cleaning and disinfection of the work area were performed.

Two experimental batches were produced on different dates, from which nine samples of each product were taken and stored between 4 and 6 °C. Five samples underwent sensory analysis, two underwent physicochemical analysis, and two were used for microbiological analysis. The raw material samples (ham, cheese, chorizo) were subjected to microbiological analysis. Physicochemical analyses of the bread, ham, cheese, and chorizo were carried out at 0 and 48 hours, while microbiological analyses of the raw materials were performed at 24 hours and for the finished product at 48 hours. Sensory analysis of the finished product was conducted 48 hours after a familiarization session.

To evaluate the physicochemical variables, the products were analyzed in duplicate. The pH of the inner mass of the sandwiches was measured in a 1:1 dilution (ISO 2917, 1999) using a Basic 20 pH meter, and the moisture content of each component was evaluated following the O'Keeffe (2005). Each portion was homogenized separately, and microbiological analysis was performed to detect contamination by total coliforms, fecal coliforms, fungi, yeasts, and mesophilic microorganisms, ensuring that the homogenization equipment was disinfected between samples.

To develop the quantitative descriptive profile, sensory descriptors were first generated by five trained evaluators through controlled association (Damasio & Costell, 1991), and the terms were later refined through open discussion (ISO 11035, 1994). The descriptors were evaluated on an unstructured 10 cm scale using a balanced block design. The data were analyzed using the Statistica (1998) and Microsoft Excel programs.

Results and discussion

The production line for ham and cheese sandwiches and assorted sandwiches was selected as it represented 39% of the total monthly services in the cold area of the UEB Gastronomía Habana Production Center. Additionally, these products had a high likelihood of microbial spoilage due to the absence of a post-handling cooking stage, which could eliminate or reduce potential contamination, especially during the slicing and assembling of the product.

The sandwiches were prepared following established procedures and the corresponding technological flow. The preparation was carried out manually in an isolated, air-conditioned room, where operators were properly dressed in compliance with good manufacturing practices. The com-

ponents were individually weighed for each sandwich and placed in the established order (ham, cheese, and chorizo).

The control of pH is very important in food production, both for controlling transformation processes and as an indicator of hygienic conditions, since a change in pH can serve as a warning of undesirable changes in the product. Factors such as temperature, pH, and moisture were crucial for food preservation. The behavior of pH during the storage of the ham and cheese sandwich and the assorted sandwich is shown in Table 1.

Table 1. Variation of pH values of the internal mass of the studied products (n= 2)

Time (h)	Ham and cheese sandwich		Assorted sandwich	
	Batch 1	Batch 2	Batch 1	Batch 2
0	5.7 (0.2)	5.85 (0.04)	5.7 (0.1)	6.02 (0.03)
48	5.9 (0.1)	5.8 (0.2)	6.1 (0.3)	5.8 (0.1)

Mean value (standard deviation).

The internal mass of the ham and cheese sandwich, consisting of cooked ham and Gouda cheese in a ratio of 80:60 g, plus 5 g of dressing, presented mean pH values ranging from 5.7 to 5.9 in the batches studied. These results, consistent with those reported by Chang et al. (2002), reflected the contribution of each raw material. Variations in pH values after 48 hours were minimal, and no significant differences ($p \leq 0.05$) were observed between batches.

It was considered unlikely that the pH of the cheese would decrease during storage, as it remained stable under refrigeration. Although the dressing could have lowered the pH, no significant deterioration in the product's shelf life was detected. The ham also showed short-term stability in refrigeration, although its spoilage could have been caused by acidification due to the development of lactic acid-producing microorganisms. It should be noted that the analysis was limited to a 48-hour period, which reduced the possibility of significant changes.

The pH results for the mixed sandwich showed a similar pattern but differed from the ham and cheese sandwich due to the addition of chorizo. The pH values for generic products varied considerably; for example, cooked ham presented a pH range of 5.57 to 6.43 (Videla & Díaz, 2017). In the case of Gouda cheese, values ranged between 5.28 and 5.32 (Méndez & Ramírez, 2020), supporting the values obtained for the ham and cheese sandwich. In the mixed sandwich, the

Table 2. Moisture values of ham and cheese sandwich and mixed sandwich (n=2)

Sandwich	Raw material	Time (h)	Batch 1	Batch 2
Ham and cheese sandwich	Top bread	0	31.8 (0.6) ab	38.3 (3.6) a
		48	27.6 (5.0) ab	21.0 (6.8) b
	Bottom bread	0	32.3 (1.2) ab	38.8 (1.5) a
		48	34.2 (7.5) ab	26.6 (2.9) b
	Cooked ham	0	62.6 (3.3) a	68.4 (1.0) a
		48	53.6 (1.6) b	53.7 (3.2) b
	Gouda cheese	0	39.8 (1.5) a	40.6 (2.1) a
		48	39.7 (1.1) a	41.4 (0.2) a
Assorted sandwich	Top bread	0	31.8 (0.6) ab	38.3 (3.6) a
		48	26.5 (2.5) b	36.4 (5.8) ab
	Bottom bread	0	32.3 (1.2) ab	38.8 (1.5) a
		48	30.0 (4.5) b	28.7 (0.9) b
	Cooked ham	0	62.6 (3.3) ab	68.4 (1.0) a
		48	54.2 (5.5) b	57.7 (2.1) b
	Gouda cheese	0	39.8 (1.5) a	40.6 (2.1) a
		48	42.9 (2.1) a	43.5 (1.2) a
	Montero chorizo	0	62.6 (1.7) a	59.7 (1.2) a
		48	55.3 (8.6) a	55.4 (1.7) a

Mean value (standard deviation).
Different letters for the same raw material indicate significant differences at $p \leq 0.05$.

pH was higher due to the influence of the chorizo, whose values vary widely depending on its composition, with reported ranges from 4.55 to 6.0 (Salgado et al., 2006).

Table 2 shows a tendency for moisture exchange between the components of both products. Although the meat products and cheese presented higher water activity (aw) than the bread, the latter did not increase its moisture content. This could be explained by the fact that the bread, being the outermost component, lost moisture to the environment since it was wrapped in a PVC film, which, although durable, was not impermeable.

Although Cuban regulations on microbiological contaminants (NC 38-02-07, 1987) have not yet established specific criteria for sandwiches or ready-to-eat foods, such as fast food, there were standards for raw materials that could serve as quality indicators (NC 78-24, 1984; NC 38-04-05, 1988). Table 3 shows the microbiological behavior of the ham and cheese sandwich and the mixed sandwich.

The ham and cheese sandwich from the second batch showed excessively high values of total coliforms, as well as fungi and yeast. The high levels of total coliforms indicated handling issues during slicing and assembly, while the elevated fungi and yeast levels likely pointed to problems associated with the bread.

The mixed sandwich also showed elevated levels of total coliforms, and one of the samples registered high counts of aerobic mesophiles. This finding led to an analysis of the raw materials, with results indicating that the main issues were related to the Gouda cheese and its handling, though no case exceeded the established limits. No fungi or yeast were detected in the analyzed raw materials. The occurrence of molds has been considered a common and recurring problem during the ripening and refrigerated storage of cheeses, usually associated with improper manufacturing or storage practices (Kandasamy et al., 2020).

Table 3. Microbiological evaluation results (CFU/g) for ham and cheese sandwich and mixed sandwich

Dish	Mesophilic aerobes	Total coliforms	Fungi and yeasts
	48 h	48 h	48 h
Ham and cheese sandwich	$9.2x10^2$	$\leq 1x10^2$	$9.2x10^3$
	$1x10^3$	$\leq 1x10^2$	$5.2x10^3$
	$1.32x10^3$	$2.16x10^3$	$1.64x10^3$
	$1.16x10^3$	$1.72x10^3$	$1.16x10^3$
Assorted sandwich	< 30	$2.24x10^4$	$\leq 1x10$
	$1.26x10^5$	$1.64x10^4$	$\leq 1x10$
	< 30	$2.84x10^3$	$\leq 1x10$
	< 30	$1.84x10^4$	$\leq 1x10$

Coliform microorganisms are good indicators of the hygienic quality of food. A high number of these microorganisms can indicate fecal contamination, as many of them originate from the intestines, suggesting the possible presence of disease-causing agents (Martin et al., 2016). However, it is important to note that confirmatory tests for fecal coliforms were negative, indicating that although corrective actions are necessary, there is no evidence of serious hygiene violations, such as failure to wash hands after using the restroom.

No positive results for fecal coliforms were found in any case. The results supported the need to improve hygiene and sanitation conditions during the production of these products, as well as to strengthen hygiene and disinfection protocols. From this perspective, it is important to note that the company worked on verifying the HACCP system, paying special attention to compliance with prerequisites. The absence of an adequate prerequisite program will hinder the effective implementation of a HACCP Plan (Jubayer et al., 2022), which will require more time and resources, and increase the risk that low-risk potential hazards may become serious threats to food safety. This program should generate records that support compliance during audits, providing the necessary environmental, infrastructure, and operational conditions for the production of safe food; additionally, like the HACCP Plan, it requires the full commitment of top management.

The sensory evaluation analysis of the products revealed that they were rated as "good" at time zero. As shown in Figure 1, significant differences were observed between the two productions, especially in internal appearance, smell, and taste. Regarding internal appearance, the changes observed in both productions were mainly attributed to defects in slicing and an uneven distribution of raw materials in the sandwich, as noted by the judges. Although the slicing was done mechanically, it was not uniform, and occasionally manual trimmings were added to meet the required weight. In terms of smell and taste, the changes could be due to a lack of stability in the quality of the raw materials provided by suppliers or the loss of freshness during the 48-hour storage period.

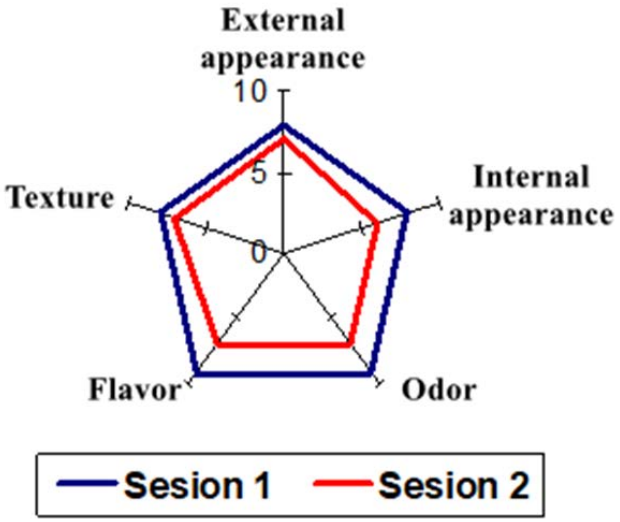

Figure 1. Quantitative descriptive profile of the ham and cheese sandwich.

As shown in Figure 2, the main difference between both productions lies in the internal appearance of the product (7.0 and 9.0, respectively), due to similar reasons observed in the ham and cheese sandwich. The defects identified by the judges when evaluating the external appearance and texture were attributed to the quality of the raw materials. However, the defects observed in the internal appearance were related to inadequate sandwich preparation, not to their storage. In contrast, the defects detected in odor and taste were related to the raw materials and the finished product storage.

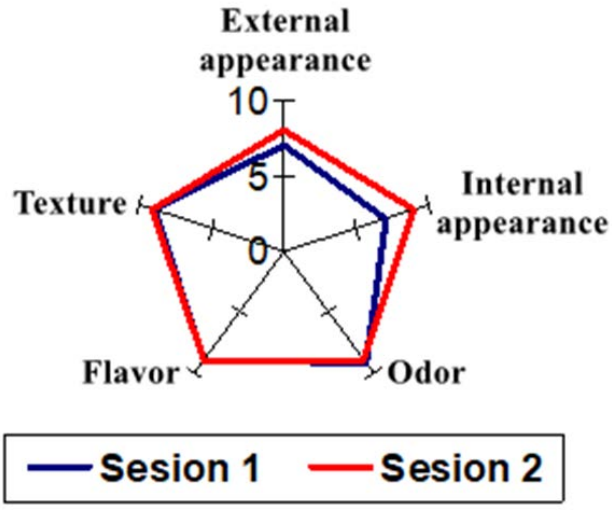

Figure 2. Quantitative descriptive profile of the assorted sandwich.

Conclusions

The variations in pH values and moisture in both products 48 hours after their preparation were minimal. In both cases, the total coliform counts were high, with the most significant hygienic-sanitary issues associated with the Gouda cheese and its handling, although no fecal coliforms were found. A descriptive sheet for the ham and cheese sandwiches and the assorted sandwiches was developed, which will allow for higher-quality sensory evaluations. The ham and cheese sandwich exhibited greater variations in sensory quality among the batches, with defects in appearance being the most impactful on the results.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Author contributions

Rosa C. Hunt and Miriam Rodríguez: 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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