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ORIGINAL ARTICLE

Evaluation of selected dishes in the cold area of the Havana Catering Base Business Unit

Evaluación de platos seleccionados en el área fría de la Unidad Empresarial de Base Catering Habana

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Abstract The objective of this work was to evaluate the hygienic-sanitary behavior of selected dishes in the cold area of the UEB Catering Habana, on board an aircraft, through a flight simulation. The airline Empresa Cubana de Aviación was chosen, given its high frequency of flights and services. Data on raw materials and finished products were analyzed from 2005 to 2007. For the simulation, dishes were prepared following the current technological flow and kept on a trolley at 20 °C for 8-10 hours. Physicochemical (pH and humidity) and microbiological analyses were performed (total count of mesophilic aerobic microorganisms, total and fecal coliforms, fungi, and yeasts). The results showed that 30.2% of the samples did not comply with the established microbiological parameters, mainly due to the presence of coliform microorganisms (40.4%) and mesophilic aerobes (32.7%). The dishes studied were highly perishable and presented pH and humidity values within the expected range. Only the cold return snack complied with the established period, while the rest showed sanitary non-compliance, attributable to inadequate handling during its preparation and assembly.

Keywords hygienic-sanitary behavior, cold catering area, microbiological analysis, flight simulation, perishable dishes, food safety compliance.

Resumen El objetivo de este trabajo fue evaluar el comportamiento higiénico-sanitario de platos seleccionados en el área fría de la UEB Catering Habana, a bordo de una aeronave, mediante una simulación de vuelo. Se eligió la aerolínea Empresa Cubana de Aviación, dada su alta frecuencia de vuelos y servicios. Se analizaron datos de materias primas y productos terminados de 2005 a 2007. Para la simulación, se prepararon platos siguiendo el flujo tecnológico vigente y se mantuvieron en un *trolley* a 20 °C durante 8-10 horas. Se realizaron análisis físico-químicos (pH y humedad) y microbiológicos (recuento total de microorganismos aerobios mesófilos, coliformes totales y fecales, hongos y levaduras). Los resultados mostraron que el 30,2 % de las muestras no cumplió con los parámetros microbiológicos establecidos, principalmente por la presencia de microorganismos coliformes (40,4 %) y aerobios mesófilos (32,7 %). Los platos estudiados, altamente perecederos, presentaron valores de pH y humedad dentro del rango esperado. Solo el snack frío de regreso cumplió con el periodo establecido, mientras que el resto mostró incumplimientos sanitarios, atribuibles a una manipulación inadecuada en su elaboración y montaje.

Palabras clave comportamiento higiénico-sanitario, área fría de catering, análisis microbiológico, simulación de vuelo, platos perecederos, cumplimiento de seguridad alimentaria.

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PUBLIS EDITORIAL

Introduction

The rise of commercial aviation, a decade after World War II, expanded the consumer market, largely driven by tourism, which considered the airplane as a fast and safe mode of transportation. This led airlines and catering companies to collaborate on developing recipes and menus that met the increasing demands of a more discerning public. For a long time, the quality of food served on board was a decisive factor when choosing an airline.

Today, air transportation has become essential, as the dynamics of modern life require shortening distances between countries and continents. This has resulted in a higher volume of operations and intense competition among airlines seeking to offer advantages such as greater time efficiency, a variety of travel options, and more comfortable flight conditions, with food offerings being a fundamental aspect. Globally, one of the biggest challenges is the production and distribution of safe food (Fróna et al., 2019). Airport catering services must ensure hygiene and food safety for passengers of different airlines (Abdelhakim et al., 2019).

In-flight catering has become one of the primary concerns for operators, as customers demand increasingly higher quality standards, making food safety an indispensable characteristic. This underscores the need for proper hygienic preparation in this service to protect the health of both the crew and the growing number of passengers and to prevent the spread of diseases through food consumption between different regions. Foods are nutritious sources for microbial growth due to their composition of sugars, fats, proteins, vitamins, minerals, and water, making it essential to reduce contamination risks and ensure safety (Alegbeleye et al., 2022; Bajić et al., 2022).

Given the above and the lack of studies on the hygienic-sanitary quality of meals during flights at UEB Catering Habana, the objective was set to evaluate the hygienic-sanitary behavior of selected dishes in the cold area of this entity through a flight simulation.

Materials and methods

A single airline was selected from those serviced by UEB Catering Habana, considering two main criteria: the weekly flight frequency and the number of services offered. Due to the high probability of contamination in dishes prepared in the cold area and the absence of a subsequent cooking stage to eliminate or reduce such contamination, this area was chosen as the focus of the study at UEB Catering Habana. The dishes were selected through a review of the client's catalog, excluding those with higher intrinsic durability, industrial products, those prepared infrequently or not at all, and those where the potential spoilage element had already been analyzed in a more complex dish.

For the retrospective analysis, results from the years 2005-2007 regarding raw materials and finished products of dishes prepared in the cold area (time zero) were examined and archived at the Quality Control Department of the Havana Catering Base Business Unit. This microbiological data came from monthly reports from the National Quality Inspection Center (CNICA), Food Control Laboratories (LACAL), and the Varadero laboratory. The information was organized by year, classifying common dishes to achieve a coherent relationship during the period.

To simulate in-flight behavior, the dishes were prepared for lunch at 15 °C, cooled in the refrigerator of the Cuban Aviation Company (ECA) between 0 and 4 °C for 27 hours, assembled on a trolley (at 15 °C), and maintained in the transit refrigerator (0 to 4 °C) for 3 hours. Subsequently, samples were taken, frozen at -10 °C, and sent to CNICA for microbiological analysis (time zero) or transferred to the Pharmacy and Food Institute (IFAL) at the University of Havana in an isothermal container to simulate flight conditions, storing the samples at 20 °C in the trolley for 8-10 hours before analysis.

Evaluations of physical and chemical attributes, such as moisture content (AOAC, 1997) and pH (ISO-2917, 1999), were conducted before the flight simulation. Two samples were taken from each batch and homogenized with their ingredients for analysis.

Microbiological analyses included the total count of mesophilic aerobic microorganisms (Nutrient Agar, 37±1 °C, 48 h), total coliform count (Violet Bile Red Agar, 37±1 °C, 48 h), fecal coliform count (Eosin Methylene Blue Agar, 37±1 °C, 24 h), and total yeast and mold count (Malt Agar, 30 °C, 48-72 h). These analyses were performed on the five selected dishes before and after each simulation. The results were statistically processed by calculating the mean and standard deviation.

Results and discussion

Cuban Aviation Company (ECA) was selected as it had the highest frequency of weekly flights and the largest number of services offered. The dishes were chosen through an analysis of the client's catalog, identifying 19 cold dishes in the Club Tropical class and 16 in the Economy class for a total of 35 dishes. Sixteen dishes were excluded due to their intrinsic durability, five for being industrial products, four for their low or nonexistent preparation frequency, and ten because the elements likely to cause spoilage had already been evaluated in more complex dishes.

After the analysis, dishes deemed at higher risk were selected for the study due to their nature, the degree of handling, and lack of cooking. These included: a vegetable appetizer consisting of corn, cucumber, carrot, beet, and chives; a fruit appetizer containing pineapple, papaya, cherry, and orange; a shrimp appetizer with shrimp, cocktail sauce, fish cocktail, orange, pineapple, and bell pepper; a cold outbound snack with smoked loin, Gouda cheese, lettuce, tomato wedge, tuna mousse, bell pepper diamond, tartlet shell, and papaya slice; and a cold return snack with cooked ham, Gouda cheese, chicken salad, bell pepper strip, natural pickle, croissant, and tartlet shell.

Between 2005 and 2007, inspections conducted by the laboratories of CNICA, LACAL, and Varadero on a representative group of raw materials and prepared dishes were analyzed. From 172 microbiological determinations, 69.8% (120 samples) met the established parameters. However, 30.2% of the samples did not comply with these standards, with no significant improvement observed over the three years analyzed. The majority of non-compliance was due to the presence of total coliforms (40.4%) and mesophilic aerobes (32.7%), reflecting issues with the handling and quality of the raw materials and the preparation process. These results underscore the need to improve compliance with HACCP system guidelines in the plant.

The dishes were prepared according to the current technological flow. In all cases, the established time and temperature parameters for their preparation were met. Adjustments were made in the flight simulation process, from preparation to final analysis. To ensure that the simulation conditions were as similar as possible to commercial conditions, the temperature was monitored during storage at IFAL. The initial, final, and average temperatures during the simulation and their standard deviations are shown in Figure 1.

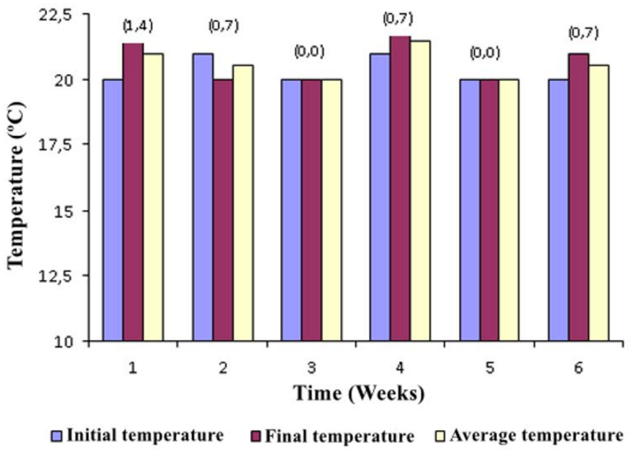

Figure 1. Behavior of temperature during simulation

The samples transported to IFAL arrived at temperatures between 0 and 2 ºC. During the storage simulation, the measurements showed adequate stability in a climate-controlled environment, with constant temperatures between 20 and 22 ºC. These fluctuations correspond to the air conditioning control system and align with the expected conditions during the flight. Although continuous temperature recording was not conducted during the simulation, the reported values are representative, as there were no interruptions in the power supply during this period.

The selected dishes may experience changes in appearance, indicating to the consumer a loss of quality, possibly attributed to changes in physical-chemical or microbiological indicators. The physical-chemical analyses performed included the measurement of moisture and pH, parameters selected for their direct relationship with the hygienic stability of the food (Table 1). Generally, products with higher water content and pH levels close to neutrality are more susceptible to spoilage, especially due to microbial action. Although the components of a dish may have different percentages of moisture and water activity (aw) values, due to the short storage time and maintenance of the cold chain, it is unlikely that moisture migration occurs between the components.

Table 1. Parameters selected for their direct relationship with the hygienic stability of foods

Food	Moisture	pH
Corn	67.6 (0.4)	-
Cucumber	96.2 (0.1)	-
Beetroot	91.9 (0.2)	-
Carrot	92.38 (0.07)	-
Pineapple	82.40 (0.01)	3.7 (0.1)
Papaya	91.04 (0.03)	5.06 (0.04)
Cherry	54.34 (0.03)	-
Orange	84.6 (0.2)	4.41 (0.02)
Smoked loin	66.3 (2.2)	5.71 (0.04)
Tuna mousse	59.72 (0.04)	5.55 (0.04)
Cooked ham	69.6 (0.8)	4.98 (0.04)
Gouda cheese	38.9 (0.2)	5.54 (0.02)
Chicken salad	54.31 (0.04)	5.42 (0.02)
Pepper	86.56 (0.09)	4.86 (0.03)
Shrimp	66.8 (1.2)	7.2 (0.1)
Cocktail sauce	54.9 (0.1)	4.30 (0.04)
Fish cocktail	75.8 (0.3)	7.0 (0.1)

Mean (Standard deviation); n= 3.

Except for the corn, the other components of the dish are high-moisture vegetables and, by their nature, present a high water activity (a_w) value. Although the pH was relatively low (below 5), the results confirm that this dish has a high probability of microbiological spoilage. Due to the mix of ingredients, which included cucumber slices, julienned carrot, and beetroot along with corn kernels, it was necessary to prepare a homogenate of the components to obtain a representative pH value of the dish.

The results indicate that among the components of this dish, papaya presented the highest risk due to its high moisture content and relatively elevated pH compared to the other ingredients. In contrast, pineapple and orange, which have lower pH values and less moisture, show a lower probability of spoilage. Although it was not possible to determine the pH of the cherry due to its small size, it is noted to be the component with the least moisture. However, since all the ingredients are in close contact, the potential for microbial spoilage should be evaluated in the context of the dish as a whole and not of individual components.

In this dish, lettuce and tomato slices were not analyzed because their portions were too small. According to moisture content, the papaya slice appeared to be the riskiest component, as it exhibited the highest moisture and pH. However, it is important to note that tuna also has high a_w values and 25 g of mayonnaise was used in the preparation of 100 g of mousse, representing a proportion of 1:3. The presence of mayonnaise in one of the dish's components is an additional factor of spoilage, as its optimal pH values range from 3 to 4.1 (Satriawan et al., 2022) to prevent spoilage. In this case, the pH of the mayonnaise was 5.55, indicating a high risk of spoilage.

Not all components of this dish were analyzed, as only those with the highest moisture values or the lowest acidity were selected. The croissant and tartlet shell were excluded from these analyses, as their spoilage causes are not primarily microbiological. Similarly, the natural pickles were not analyzed due to their natural acidification. Regarding the analyses performed, it is relevant to mention the presence of bell pepper in this dish; although it is the component with the highest moisture, it also has the lowest pH. On the other hand, other ingredients in this dish, such as the chicken salad (which includes steamed boneless chicken breast, ma-

Table 2. Microbiological analysis of the dishes (cfu/g)

Dish	Batch	Mesophilic aerobes		Total coliforms		Fungi		Yeast	
		0 h	40 h	0 h	40 h	0 h	40 h	0 h	40 h
Vegetable appetizer	1	$1x10^3$	$1.28x10^3$	$1x10^2$	$1.16x10^3$	NP	$<1x10$	NP	$<1x10^2$
		$1x10^3$	$1.96x10^3$	$1x10^2$	$1.28x10^3$		$<1x10$		$<1x10^2$
		$1x10^3$	$1.72x10^3$	$1x10^2$	$1.08x10^3$		$<1x10$		$<1x10^2$
		$1x10^3$	$2.40x10^3$	$1x10^2$	$9.6x10^2$		$1.5x10^3$		$<1x10^2$
	2	$2x10^3$	$3.4x10^3$	$2.9x10^2$	$1x10^2$	NP	$<1x10$	NP	$<1x10^2$
		$2x10^3$	$3.8x10^3$	$2.9x10^2$	$2.6x10^3$		$<1x10$		$<1x10^2$
		$2x10^3$	$1x10^5$	$2.9x10^2$	$1x10^2$		$6x10^2$		$5.0x10^2$
		$2x10^3$	$9.2x10^4$	$2.9x10^2$	$<1x10^2$		$5.6x10^2$		$1.3x10^3$
Fruit appetizer	1	$1.7x10^4$	$1.28x10^3$	$6.1x10^2$	$<1x10^2$	NP	$<1x10$	NP	$3.4x10^2$
		$1.7x10^4$	$1.44x10^3$	$6.1x10^2$	$<1x10^2$		$<1x10$		$2x10^2$
		$1.7x10^4$	$1.44x10^3$	$6.1x10^2$	$1x10^3$		$3x10$		$1.5x10^3$
		$1.7x10^4$	$1.48x10^3$	$6.1x10^2$	$7.2x10^3$		$1.5x10^3$		$9.4x10^2$
	2	$3.7x10^4$	$5.2x10^4$	$3.6x10^2$	$2.08x10^3$	NP	$1.7x10^3$	NP	$<1x10^2$
		$3.7x10^4$	$4.8x10^4$	$3.6x10^2$	$2.04x10^3$		$4x10^3$		$<1x10^2$
		$3.7x10^4$	$3x10^4$	$3.6x10^2$	$3.96x10^3$		$6.4x10^2$		$<1x10^2$
		$3.7x10^4$	$3.1x10^4$	$3.6x10^2$	$1.52x10^3$		$<1x10$		$<1x10^2$
Cold outbound snack	1	$6.8x10^2$	$1.16x10^3$	$<1x10^2$	$1.72x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$3.6x10^2$	$2.56x10^3$	$<1x10^2$	$1x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$7.2x10^2$	$1.52x10^3$	$5.6x10^2$	$1.12x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$4x10^2$	$2.16x10^3$	$1.84x10^3$	$1.04x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
	2	$5.2x10^2$	$1.64x10^3$	$4.5x10^2$	$6x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$6.2x10^2$	$1.18x10^3$	$3.4x10^2$	$9.6x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$8.4x10^2$	$1.24x10^3$	$1.44x10^3$	$1.2x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$1x10^3$	$1.04x10^3$	$1.85x10^3$	$1.08x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
Cold return snack	1	$1.56x10^3$	$1.24x10^4$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$1.72x10^3$	$1.18x10^4$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$1.80x10^3$	$1.08x10^5$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$1.40x10^3$	$1.04x10^5$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
	2	$5.3x10^2$	$2.56x10^3$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$4.8x10^2$	$3.96x10^3$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$2.24x10^3$	$1.56x10^3$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$1.28x10^3$	$2.00x10^3$	$<1x10^2$	$<1x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
Shrimp appetizer	1	$1.44x10^3$	$2.16x10^4$	$4.4x10^2$	$6.5x10^2$	$<1x10$	$<1x10$	$<1x10$	$9.6x10^2$
		$1.88x10^3$	$2.12x10^4$	$<1x10^2$	$4.5x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$8.4x10^2$
		$1.24x10^3$	$2.02x10^4$	$<1x10^2$	$8.4x10^2$	$<1x10$	$<1x10$	$<1x10^2$	$6.4x10^2$
		$1.72x10^3$	$2.04x10^4$	$<1x10^2$	5.2x102	$<1x10$	$<1x10$	$<1x10^2$	$3.9x10^2$
	2	$2.4x10^3$	$9.6x10^4$	$5.4x10^2$	$1.44x1^2$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$2.12x10^3$	$8.8x10^4$	$<1x10^2$	$1.56x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$<1x10^2$
		$1.24x10^3$	$8.0x10^4$	$<1x10^2$	$2.52x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$6.5x10^2$
		$1.52x10^3$	$3.8x10^4$	$<1x10^2$	$2.40x10^3$	$<1x10$	$<1x10$	$<1x10^2$	$4.6x10^2$

NP: Not performed.

yonnaise, salt, pepper, and parsley), are highly susceptible to microbiological spoilage. It is important to highlight that mayonnaise was the main cause of foodborne illnesses in Latin America and the Caribbean between 1993 and 2002 and can harbor dangerous microorganisms for health, such as *Escherichia coli* O157:H7, *Listeria monocytogenes*, and *Salmonella* spp., the latter originating from the egg used in its preparation (Guerra et al., 2016). Therefore, the pH of this dish indicates a high risk of spoilage.

The composition of this dish makes it vulnerable to microbiological contamination, especially due to the presence of shrimp and seafood cocktails. The cocktail sauce that accompanies the dish contains 80% mayonnaise, which places it in the danger zone due to its pH. Moreover, both shrimp and seafood cocktails have a pH close to or above 7, which increases the risk of microbial spoilage. The moisture and pH of the different components are consistent with those reported in the literature (USDA, 2008). In general, the results of the physical-chemical analyses support the appropriateness of selecting these dishes, as they are classified as high-risk.

The count of microorganisms in food is crucial, as they are not sterile and can carry pathogens or toxins, posing a risk to consumer health. Table 2 presents the results of the microbiological analyses conducted.

In the values obtained at time zero, it was observed that four dishes did not comply with NC 38-02-07 (1987) regarding total coliform counts, indicating handling issues and reflecting a lack of improvement in this aspect, as the retrospective analysis also revealed high coliform counts in those dishes. Although other microorganisms met the specifications, no counts of fungi and yeasts were performed on the fruit and vegetable appetizers. In the simulation, it was confirmed that four out of the five dishes had total coliform counts that did not meet specifications, as expected based on the initial results.

The results indicated handling problems during the preparation and assembly of the dishes. It was noted that the fruit, vegetable, and shrimp appetizers did not meet the established parameters for yeast and mold counts. This may have been due to the favorable pH of fresh fruits and vegetables for the growth of these microorganisms, as well as the inclusion of vegetables in the shrimp appetizer. Coliform microorganisms are key indicators of the hygienic quality of food, and their presence may suggest fecal contamination, as they are usually of intestinal origin (Martin et al., 2016). Despite finding a large number of coliforms, confirmatory tests for fecal coliforms in the five dishes were negative, both at time zero and after the simulation. This suggests that, while it is necessary to improve staff practices, there are no indications of serious violations of hygiene and sanitation procedures, such as handwashing. However, the results reveal that, although serious violations have not been detected, handling problems persist that have led to a significant percentage of non-compliance in health inspections. Therefore, it is essential to continue refining the control mechanisms established in the entity.

Conclusions

The retrospective analysis of the raw materials and dishes prepared by the entity revealed that 30.2% of the samples did not meet the established microbiological parameters. Most of the non-compliances were associated with the presence of total coliform microorganisms (40.4%), mesophilic aerobes (32.7%), as well as fungi and yeasts (16.9%). The studied dishes are highly perishable, according to the pH values and moisture content obtained, which fall within the expected range. Of the five dishes analyzed, only the cold snack for the return trip met the established period, while the others showed health non-compliance before the simulation. These microbiological results indicate that the main problem in the preparation and assembly of the dishes is related to inadequate handling.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Author contributions

Yelaín Álvarez and Raúl Díaz: 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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