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Applied Research Article

The Effect of Changes in the Storage Temperature and Acceptability of Animal-Based Food Ingredients in the Refrigerated Room of HODASCO 19

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Abstract: This study examined how refrigerated-room temperature affected the acceptability of animal-based food ingredients (chicken, beef, and fish) stored on board HODASCO 19. The study used a descriptive quantitative design based on organoleptic observation. Five assessors evaluated odour, colour, and texture using a five-point Likert scale for samples stored at −18 °C, 0 °C, and 4 °C over four weeks. Mean scores were calculated and interpreted using fixed acceptability intervals. The results show a clear temperature effect. Storage at −18 °C maintained the highest acceptability throughout the observation period, with mean scores remaining in the very acceptable category (4.86–5.00). Storage at 0 °C showed the sharpest decline, dropping from very acceptable at week 0 to unacceptable by week 2 and highly unacceptable by weeks 3–4. Storage at 4 °C performed better than 0 °C in this onboard dataset but still declined from very acceptable at week 1 to moderately acceptable at week 3 and unacceptable at week 4. The findings confirm that low and stable storage temperatures are essential for preserving the quality of perishable animal-based food ingredients on board ships. Practically, the refrigerated room should be maintained as close as possible to −18 °C for longer storage, while short-term storage at higher temperatures requires stricter monitoring.

Keywords: ships, cold storage, storage temperature, animal feed ingredients

1. Introduction

Food storage is a critical operational issue on board ships because crew members depend entirely on available provisions during voyages. When food quality declines, the consequences are not limited to taste or appearance; they also affect safety, nutrition, morale, and work performance. For that reason, the management of refrigerated rooms is directly linked to crew welfare and maritime operational reliability.

Previous maritime studies have shown that the performance of ship refrigeration systems affects the condition of stored food ingredients. When the cooling system does not reach the target temperature or when doors are opened too frequently, food quality declines more rapidly. In practical terms, the earliest visible signs of deterioration are usually organoleptic: abnormal odour, colour change, and textural softening.

The broader food-preservation literature also supports the importance of storage temperature. Frozen storage slows microbial growth and deteriorative reactions in meat, while refrigerated storage above the freezing point is suitable only for shorter periods and demands stable temperature control [1], [2]. Fish is particularly perishable, and both chilling and freezing remain the most common preservation methods used on board vessels [3]. Storage time interacts with temperature, meaning that quality deterioration is not determined by temperature alone but by how long the product remains under that condition [4].

The gap in the present manuscript lies in the limited availability of shipboard case studies that

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connect practical refrigerated-room conditions with direct acceptability assessment of food ingredients stored for crew consumption. Most previous works discuss cooling machinery or general preservation theory, but fewer studies report observational evidence from actual ship operations. Accordingly, this study focuses on HODASCO 19 as an onboard case and evaluates the acceptability of chicken, beef, and fish stored at three temperature settings: −18 °C, 0 °C, and 4 °C.

This study aims to analyse the effect of storage temperature on the acceptability of animal-based food ingredients in the refrigerated room of HODASCO 19 using three practical indicators—odour, colour, and texture. The study contributes by translating a routine onboard storage problem into a structured comparative assessment that can support operational decisions in ship catering and refrigerated-room management.

2. Materials and Methods

2.1 Research Design

This study employed a descriptive quantitative observational design. This design was selected because the study aimed to describe and compare changes in product acceptability under different storage temperature conditions without applying experimental manipulation beyond the predetermined storage treatments.

The analysis focused on the comparative pattern of acceptability scores observed under three storage temperatures. The main objective was to identify trends in sensory acceptance, including whether the acceptability level remained stable, decreased, or showed different patterns across storage conditions. Therefore, the interpretation of the results was based on descriptive comparison of the observed scores rather than hypothesis testing using inferential statistics.

In this study, the acceptability data were presented quantitatively to provide a clear overview of the product's sensory quality during storage. The descriptive approach allowed the researchers to evaluate the relationship between storage temperature and consumer acceptability in a practical manner. This design is appropriate for preliminary quality evaluation studies, especially when the emphasis is placed on observing score patterns and identifying potential storage conditions that better maintain product acceptability.

2.2 Research Setting and Materials

The study was conducted on board HODASCO 19, specifically in the refrigerated storage room used for food logistics during voyage operations. This setting was selected because refrigerated rooms on board vessels play an important role in maintaining the quality and safety of food ingredients throughout the voyage. The storage condition in this room represents the actual operational environment in which food materials are stored before being prepared and consumed by the crew.

The materials observed in this study were animal-based food ingredients consisting of chicken, beef, and fish. These three ingredients were selected because they are commonly used as food supplies on board and are highly sensitive to changes in storage temperature. Animal-based food products are also more susceptible to quality deterioration, including changes in appearance, odor, texture, and overall acceptability, when stored under unsuitable temperature conditions.

The observation period lasted for four weeks, from week 0 to week 4. Week 0 represented the initial condition of the food materials before storage observation, while weeks 1 to 4 represented the subsequent observation periods under refrigerated storage conditions. During this period, the acceptability of chicken, beef, and fish was observed to identify changes in sensory quality over time. All sections of this study consistently treated chicken, beef, and fish as the main research objects.

2.3 Assessors and Instrument

This study involved five respondents who served as assessors in the acceptability evaluation. The assessors were asked to observe and score the condition of the food materials based on predetermined sensory indicators. Although the number of assessors was limited, the panel was considered appropriate for descriptive onboard observation because the study focused on identifying practical changes in food acceptability during storage rather than conducting formal laboratory-based sensory testing.

Acceptability was assessed using an

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observation sheet with a five-point Likert scale. The assessment covered three main indicators: odour, colour, and texture or physical condition. These indicators were selected because they represent direct and observable signs of quality deterioration in animal-based food ingredients stored under refrigerated shipboard conditions. Odour indicates possible spoilage or freshness loss, colour reflects visual changes in product quality, and texture or physical condition represents changes in firmness, surface appearance, and overall material integrity.

In this scale, a higher score indicated better acceptability, while a lower score indicated a decline in sensory quality. The use of a structured observation sheet helped ensure that all assessors applied the same criteria when evaluating chicken, beef, and fish samples throughout the observation period.

2.4 Scoring Procedure

The food samples were stored under three temperature conditions, namely −18 °C, 0 °C, and 4 °C. Observations were conducted at weekly intervals from week 0 to week 4. At each observation time, the assessors evaluated the condition of the food materials based on odour, colour, and texture or physical condition.

Each assessor assigned a score using the five-point Likert scale provided in the observation sheet. The scores from the five assessors were then averaged for each food material, storage temperature, and observation week. The mean score was used to describe the level of acceptability under each storage condition.

The category intervals were determined using the class-interval formula, namely the maximum score minus the minimum score divided by the number of categories. Based on the five-point Likert scale used in this study, the interval value was calculated as (5 − 1) / 5 = 0.8. Therefore, each acceptability category had an interval width of 0.8, which provided a consistent basis for interpreting the mean acceptability scores.

2.5 Category Interpretation

The mean acceptability scores were interpreted using five categories. A score range of 4.21–5.00 was classified as very acceptable, indicating that the food material remained in very good sensory condition. A score range of 3.41–4.20 was classified as acceptable, indicating that the food material was still suitable based on the observed sensory indicators.

A score range of 2.61–3.40 was classified as moderately acceptable, indicating that the food material showed signs of quality decline but was not yet considered fully unacceptable based on the descriptive observation. A score range of 1.81–2.60 was classified as unacceptable, while a score range of 1.00–1.80 was classified as highly unacceptable. These categories were used to provide a clearer and more academic interpretation of the observed acceptability levels. The interpretation categories used in this study are presented as shown in Table 1.

Table 1. Acceptability Score Interpretation Categories

Mean Score Range	Category
4.21–5.00	Very acceptable
3.41–4.20	Acceptable
2.61–3.40	Moderately acceptable
1.81–2.60	Unacceptable
1.00–1.80	Highly unacceptable

2.6 Validity and Reliability Basis

The instrument used in this study was developed based on content validity at the indicator level. The selected indicators, namely odour, colour, and texture or physical condition, are commonly used as organoleptic indicators to assess the sensory quality and deterioration of food materials. These indicators were considered relevant to the operational context of shipboard food storage because they can be observed directly without requiring laboratory equipment.

Scoring consistency was maintained by using the same observation sheet, scoring scale, and assessment criteria for all samples, storage temperatures, and observation periods. All assessors evaluated the samples using the same rubric, which helped reduce variation in interpretation during the scoring process. Because this study used a limited onboard observational panel and descriptive analysis, the findings should be interpreted as descriptive operational evidence rather than laboratory validation of food safety. The results provide practical information on changes in the acceptability of chicken, beef, and fish under different refrigerated storage temperatures during voyage operations.

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2.7 Data Analysis

The data obtained from the observation sheet were analysed descriptively using mean scores. The scores given by the five assessors were averaged for each food material, storage temperature, and observation week. The mean values were then used to describe the level of acceptability of chicken, beef, and fish under different refrigerated storage conditions.

The analysis focused on comparing the pattern of acceptability changes across the three storage temperatures, namely −18 °C, 0 °C, and 4 °C, during the observation period from week 0 to week 4. The comparison was conducted to identify which storage temperature was more effective in maintaining the sensory quality of animal-based food ingredients during shipboard storage.

The observed patterns were interpreted in relation to food preservation theory and the operational context of refrigerated storage on board vessels. In general, lower storage temperatures are expected to slow down quality deterioration by reducing microbial activity and biochemical changes in food materials. Therefore, changes in odour, colour, and texture were used as practical indicators to evaluate the acceptability of the stored materials. The mean scores were interpreted using the acceptability category intervals presented in Table 2. These categories provided a consistent basis for describing whether the observed food materials remained very acceptable, acceptable, moderately acceptable, unacceptable, or highly unacceptable during the storage period.

Table 2. Acceptability Category Intervals

Mean Score	Interpretation
4.21–5.00	Very acceptable
3.41–4.20	Acceptable
2.61–3.40	Moderately acceptable
1.81–2.60	Unacceptable
1.00–1.80	Highly unacceptable

3. Results

3.1 Overview of Acceptability Results

The descriptive results show that storage temperature affected the acceptability of chicken, beef, and fish during the four-week observation period. The acceptability scores were obtained from the assessment of odour, colour, and texture or physical condition, as described in the methodology. The mean score was then used to represent the overall acceptability level of the observed food materials under each storage temperature.

In general, the results indicate that lower-temperature storage was more effective in maintaining food acceptability over time. However, the rate of decline was not identical across the three storage temperatures. Therefore, a comparative interpretation was necessary to understand how each storage condition influenced the acceptability pattern from week 0 to week 4.

3.2 Acceptability Pattern at −18 °C

At −18 °C, the acceptability scores remained consistently high throughout the observation period. The mean score decreased only slightly from 5.00 at week 0 to 4.86 at week 4. Based on the interpretation category, all weekly scores at −18 °C remained in the “very acceptable” category. This result indicates that freezing temperature was able to maintain the sensory quality of animal-based food materials more effectively than the other storage temperatures. The very small decrease in score suggests that changes in odour, colour, and texture were minimal during the four-week storage period.

3.3 Acceptability Pattern at 0 °C

At 0 °C, the acceptability score declined more sharply compared with −18 °C. The mean score decreased from 5.00 at week 0 to 3.47 at week 1, indicating that the food materials were still in the “acceptable” category. However, the score dropped further to 2.49 at week 2, which falls into the “unacceptable” category. By week 3, the mean score reached 1.81 and remained within the “unacceptable” category based on the category interval used in this study. At week 4, the score declined further to 1.21, which indicates a “highly unacceptable” condition. This pattern shows that storage at 0 °C was not sufficient to maintain acceptability for a longer period under the observed shipboard storage conditions.

3.4 Acceptability Pattern at 4 °C

At 4 °C, the decline in acceptability occurred gradually during the observation period. The mean score decreased from 5.00 at week 0 to 4.80 at week 1, and both scores were classified as

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"very acceptable." At week 2, the score declined to 3.63, which was categorized as "acceptable." The score continued to decrease to 3.20 at week 3, placing it in the "moderately acceptable" category. By week 4, the mean score reached 2.46 and was categorized as "unacceptable." This result indicates that storage at 4 °C could maintain acceptability during the early weeks of observation, but the quality of the food materials declined noticeably by the final week.

3.5 Comparative Acceptability Across Storage Temperatures

The comparison among the three storage temperatures shows that −18 °C provided the most stable acceptability scores during the four-week observation period. This storage condition maintained all observed food materials in the "very acceptable" category until week 4. In contrast, 0 °C showed the fastest decline, reaching the "unacceptable" category by week 2 and "highly unacceptable" by week 4.

The 4 °C storage condition showed a more gradual decline than 0 °C in this dataset. Although the score eventually reached the "unacceptable" category at week 4, the acceptability remained higher than that of 0 °C during weeks 1 to 4. This difference suggests that the observed acceptability pattern was influenced not only by temperature level, but also by practical storage conditions on board, such as handling, exposure during observation, air circulation, and possible variation in sample condition.

Overall, the results demonstrate that −18 °C was the most effective storage temperature for maintaining the acceptability of chicken, beef, and fish over four weeks. Meanwhile, storage at 0 °C and 4 °C resulted in a progressive decline in acceptability, indicating that these temperatures were less suitable for maintaining animal-based food materials over an extended storage period.

Table 2. Mean Acceptability Scores by Storage Temperature and Week

Temperature	Week	Mean Score	Category
−18 °C	0	5.00	Very acceptable
−18 °C	1	4.99	Very acceptable
−18 °C	2	4.96	Very acceptable
−18 °C	3	4.91	Very acceptable
−18 °C	4	4.86	Very acceptable
0 °C	0	5.00	Very acceptable
0 °C	1	3.47	Acceptable
0 °C	2	2.49	Unacceptable
0 °C	3	1.81	Unacceptable
0 °C	4	1.21	Highly unacceptable
4 °C	0	5.00	Very acceptable
4 °C	1	4.80	Very acceptable
4 °C	2	3.63	Acceptable
4 °C	3	3.20	Moderately acceptable
4 °C	4	2.46	Unacceptable

4. Discussion

The results support the general principle that lower storage temperatures preserve the quality of perishable animal-based food ingredients for longer periods. The strong performance of −18 °C is consistent with the literature on frozen storage, which shows that low temperatures suppress microbial activity and reduce deteriorative reactions, thereby extending shelf life [1]. This explains why the samples stored at −18 °C remained in the very acceptable category throughout the four-week observation period.

The practical significance for ship operations is direct. On board a vessel, provisions are not replenished continuously, so storage failure accumulates risk over time. If refrigerated-room temperatures are not sufficiently low or not sufficiently stable, crew food quality can decline before the end of the intended storage period. The present findings therefore reinforce the need for temperature discipline, routine monitoring,

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and minimisation of door-opening frequency during voyages.

An important point in this dataset is that 0 °C produced a steeper decline than 4 °C. In a purely theoretical framework, one might expect 0 °C to preserve quality at least as well as, or better than, 4 °C. Because this was an onboard observational study rather than a controlled laboratory experiment, the most plausible interpretation is that the 0 °C condition may have been more vulnerable to operational fluctuation, partial freezing-thawing effects, or inconsistent exposure during handling. This discrepancy should not be ignored or concealed; instead, it highlights the importance of temperature stability, not merely nominal set-point temperature.

The pattern observed at 4 °C remains meaningful. Although 4 °C is often used for chilled storage over shorter periods [2], [3], the scores in this study still declined to unacceptable by week 4. That means 4 °C may be operationally tolerable for short-term holding, but it is not appropriate for extended shipboard storage of highly perishable ingredients. This is especially relevant for fish, which the literature identifies as particularly susceptible to rapid deterioration [3].

The study also confirms the value of organoleptic indicators in shipboard practice. Odour, colour, and texture are not equivalent to microbiological tests, but they are practical early-warning indicators for cooks, stewards, and vessel personnel responsible for provisions. In the constrained environment of a ship, rapid sensory screening can help identify declining quality before food is prepared and consumed. This study has limitations. First, it used a small descriptive panel of five assessors. Second, the analysis relied on mean scores and did not include microbiological, physicochemical, or instrumental measurements. Third, the revised manuscript reflects the available onboard dataset, so the exact mechanism behind the unexpectedly poor 0 °C performance cannot be established conclusively. Future research should combine temperature loggers, microbial counts, and ingredient-specific analysis to strengthen causal interpretation.

5. Conclusion

Storage temperature had a clear effect on the acceptability of chicken, beef, and fish stored in the refrigerated room of HODASCO 19. Based on the descriptive observation, the most effective storage condition was −18 °C, which maintained the food materials in the very acceptable category throughout the four-week observation period. This result indicates that frozen storage was able to preserve the sensory quality of animal-based food ingredients more consistently than the other temperature conditions.

In contrast, storage at 0 °C showed the fastest decline in acceptability in this dataset. The acceptability score decreased sharply after the first week and reached an unacceptable condition in the following weeks. Meanwhile, storage at 4 °C showed a more gradual decline, but the acceptability level fell below the acceptable threshold by the fourth week. This finding suggests that 4 °C storage may still be suitable for shorter-term storage, but it is not recommended for extended storage periods without strict monitoring.

Scientifically, this study confirms that low and stable storage temperatures are essential for slowing the deterioration of perishable animal-based food ingredients under shipboard conditions. Changes in odour, colour, and texture can be used as practical indicators to evaluate the decline in food acceptability during refrigerated storage. From an operational perspective, frozen storage at −18 °C should be prioritised for longer voyages, particularly for highly perishable food materials such as chicken, beef, and fish. Chilled storage conditions, such as 0 °C and 4 °C, require shorter holding periods, regular quality inspection, and better temperature control to reduce the risk of quality deterioration.

This study is limited by its descriptive design, small number of onboard assessors, and reliance on sensory observation without laboratory-based food quality testing. Therefore, future research should include microbiological analysis, physicochemical measurements, and continuous temperature logging to provide a more comprehensive evaluation of food quality and safety during shipboard storage.

Conflict of Interest declaration: This research has no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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