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Short Communication

Seasonal changes influence preferences for the sensory profiles of ice cream

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ABSTRACT

Ice cream is one of the most popular sweet foods in the world. It is primarily consumed during summer, but is available in the market all year. However, the influence of seasons on the desirable food-intrinsic and food-extrinsic sensory attributes of ice cream products to consumers remains elusive. In order to fill this gap, the present study examined how the seasonal context (summer vs. winter) influences consumers' desirable intrinsic (taste, flavour, texture, and temperature) and extrinsic (packaging colour design) sensory attributes of vanilla ice cream. In summer and winter, Japanese participants were asked to imagine eating vanilla ice cream and to evaluate their preferred sensory profile and packaging colour. The results have demonstrated that the Japanese participants preferred different sensory profiles of vanilla ice cream depending on the season. In summer (vs. winter), sensory attributes associated with cooling, particularly coolness and hardness, were preferred, whereas in winter (vs. summer), indulgent qualities, such as richness, smoothness, milkiness, and fattiness, were preferred. Regarding packaging colour preferences, light blue was especially preferred in summer but was significantly avoided in winter. In contrast, warmer tones such as dark red and yellow are preferred in winter. Notably, the cream exhibited consistently high appeal across both seasons. These findings provide converging evidence that the seasonal context dynamically shapes consumers' preferences for both food-intrinsic and extrinsic desirable sensory attributes and provide actionable insights for practitioners.

1. Introduction

Ice cream is one of the most popular sweet foods in the world. In terms of market size, the global ice cream industry is valued at an estimated USD 92.5 billion in 2025, with projections indicating growth to USD 111.8 billion by 2030 (Mordor Intelligence, 2025). Ice cream is primarily consumed during summer, but is available in the market every year. For instance in Japan, national sales data from the Japan Ice Cream Association show that while consumption peaks in July and August, notable sales volumes persist across all months of the year, including winter months such as December and January (Japan Ice Cream Association, 2023). Furthermore, ice cream consumption during winter has shown a gradual upward trend in Japan over the past five years (Japan Ice Cream Association, 2024). These data highlight the importance of designing the sensory characteristics of ice cream to suit seasonal preferences.

One stream of research focused on the food-intrinsic factors of ice cream (e.g., Guinard et al., 1996). Food-intrinsic factors refer to the inherent physical and sensory properties of a food product (e.g. taste, flavour, aroma, texture, and composition) (Wang et al., 2019). Some previous studies have manipulated ingredients (e.g. reduced fat and sugar) and explored the sensory profiles of vanilla ice cream, positively influencing consumer acceptance (e.g., Guinard et al., 1996). For example, one study suggested that sugar, and to a lesser extent fat, is a critical driver of ice cream acceptability, with both overly low and high levels diminishing product quality (Guinard et al., 1996).

Another stream of research has focused on the food extrinsic factors of ice cream (Otterbring et al., 2022; Van Rompay et al., 2018). Food-extrinsic factors refer to contextual attributes that are not part of the intrinsic sensory properties of food (e.g. packaging colour, background music; (Wang et al., 2019)). For example, prior research used extrinsic-sensory characteristics, such as cup surface texture (Van Rompay et al., 2018), typefaces used on cups (Otterbring et al., 2022), visual poster design (Van Rompay et al., 2018) and their impact on ice cream preference, taste, and flavour evaluations. Consequently, whether the effects of the intrinsic and extrinsic food factors on ice cream evaluation differ across seasons remains unexplored.

Several past studies have shown that season affects food consumption patterns (Charles Spence, 2021) for a review). Most studies have focused on seasonal differences in food consumption and energy intake

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(Charles Spence, 2021). Meanwhile, other past studies have revealed seasonal differences in sensory perception and preferences, especially when using odours (e.g., Seo et al., 2009; Tran et al., 2023). For example, a certain odour (e.g. cinnamon) is preferred during the Christmas season over summer (Seo et al., 2009). However, to the best of our knowledge, no research has tested how seasons influence consumers' desirable sensory attributes (e.g. taste, flavour, and texture) and packaging colour design in food and beverage products, at least when using ice cream products.

1.1. The current research

In order to fill this gap in the literature, the current research examined whether the effects of intrinsic and extrinsic food factors on ice cream evaluation differ across seasons. Specifically, in two seasons (summer and winter), Japanese participants rated the desirability of food-intrinsic (i.e. taste, flavour, and texture) and food-extrinsic (i.e. packaging colour) sensory profiles of ice cream products. We believe that Japan offers an ideal context for investigating seasonal effects on consumer preferences as it experiences four distinct seasons with particularly pronounced temperature differences between summer and winter. Vanilla flavour was used in our research because vanilla ice cream is regarded as the most popular flavour (e.g., Gitnux, 2024) and it is sold year-round in Japan.

Our theoretical basis is thermoregulation through food intake (Motoki et al., 2018). Thermoregulation theory suggests that people select and prefer foods that efficiently regulate their thermoregulatory needs (Motoki et al., 2018). In warm temperatures, people (and animals in general) may be motivated to select foods that aid in reducing their body temperature, whereas at cold temperatures, they are not motivated to do so (e.g., Motoki et al., 2018). Prior studies have shown that the thermal properties of foods (typically hot or cold) can influence their preference depending on the ambient temperature (Motoki et al., 2018). For example, warm (vs. cool) temperatures induce people to prefer colder foods (e.g. sushi), while cold (vs. warm) temperatures induce people to prefer warmer foods (e.g. pizza) (Motoki et al., 2018).

Based on this reasoning, it is reasonable to expect that the desirable sensory characteristics of ice cream will be evaluated differently depending on the season. In particular, attributes associated with coolness and/or those that contribute to reducing body temperature (e.g. the physical coolness of ice cream and cool-coloured packaging) are expected to be more strongly preferred in summer than in winter. Meanwhile, attributes connoting warmth and/or those perceived to increase body temperature (e.g. fattiness and richness of the ice cream) are expected to be more strongly preferred in winter than in summer.

2. Methods

2.1. Participants

2.1.1. Summer sample

The participants were recruited via a crowdsourcing platform (CrowdWorks) between 23 July and 25, 2024. The eligibility criteria included being 18 years or older and regularly purchasing and consuming ice cream (at least once a month throughout the year). A total of 300 participants took part in the survey (140 men, 160 women; M = 40.89 years, SD = 10.27).

2.1.2. Winter sample

The participants were recruited via the same crowdsourcing platform between 10 December and 11, 2024. The same eligibility criteria were applied in this study. A total of 274 participants participated in the survey (128 men, 145 women, and one other; M = 42.57 years, SD = 9.66).

2.2. Survey procedures

2.2.1. Desirable sensory attributes

Participants were asked to imagine eating vanilla ice cream that would be ideal for the current season (see Appendix A for a screenshot of the exact question). They were instructed to respond based on what they considered ideal for vanilla ice cream in the current season (i.e. summer or winter, depending on the survey period). They evaluated the desirable sensory characteristics of the ice cream. Using 101-point sliders (ranging from 0 = "Not desirable at all" to 100 = "Extremely desirable"), they rated the following attributes. The order of the attributes was randomised among the participants.

- Sweetness: Perceived sweetness of the ice cream
- Hardness: Force required to compress the ice cream in the mouth
- Density: Compactness of the ice cream when compressed in the mouth
- Fattiness: Perceived fat content when eating
- Coolness: Degree of coldness felt when eating the ice cream
- Milkiness: Strength of the milk flavour
- Richness: Overall flavour richness of the ice cream
- Smoothness: Smooth, creamy mouthfeel
- Vanilla flavour: Flavour of vanilla extract
- Custard flavour: Custard-cream-like flavour similar to that of choux cream or egg-based custard.

These ten sensory attributes were selected based on previous research involving ice cream evaluation (e.g., Thompson et al., 2009) and further refined through insights from the second and subsequent authors, who have direct experience in the ice cream industry. We conducted a follow-up study to assess whether these attributes were sufficient for evaluating vanilla ice cream across seasons. The results showed that 95 % of the participants considered the ten attributes to be generally adequate for evaluating vanilla ice cream in both summer and winter (see Appendix B for details).

2.2.2. Desirable package colour

Participants were then asked to indicate which colour they would most prefer for the packaging of vanilla ice cream during the current season. Fourteen colour swatches (black, blue, brown, green, grey, orange, pink, purple, red, white, yellow, light blue, light green, and cream) were displayed on the screen, and participants selected the one they found most desirable. The order of the swatches was randomised for each participant. Appendix C shows a screenshot of the exact question and Appendix C provides the precise HEX and RGB values used in the study. Follow-up evaluation confirmed that the independent participants reliably recognised the 14 colour swatches on their own devices and browsers (99.35 % accuracy; see Appendix E for details). This result supports the prediction that colour swatches are perceived as intended and validates their use in screen-based presentations.

The selection of colour stimuli was guided by prior academic research and expert input. Eleven colours (black, blue, brown, green, grey, orange, pink, purple, red, white, and yellow) were identified in previous studies of colour–taste correspondences (e.g., Wan et al., 2014). In addition, three supplementary colours—light blue, light green, and cream—were included based on practical insights provided by the second and subsequent authors, who have direct experience in the ice cream industry. Our follow-up analysis demonstrated that this set of colours sufficiently captured the packaging colours that consumers associate with vanilla ice cream during summer and winter. Specifically, 99 % of participants reported that they included their preferred packaging colours for both seasons (see Appendix B for details).

2.3. Statistical analyses

To examine how consumer preferences for the sensory attributes of

ice cream varied by season, we conducted mixed-design analysis of variance by season (summer vs. winter) as a between-participants factor and sensory attributes (10 levels: sweetness, hardness, density, etc.) as within-participants factors. When significant interactions emerged, simple effect analyses were performed to explore the differences in attribute ratings between seasons. To further evaluate the relative importance of different sensory attributes within each season, we conducted post-hoc multiple comparisons using Shaffer's modified sequentially rejective Bonferroni procedure.

For package colour preferences, we constructed a contingency table to cross-tabulate the participants' preferred package colours (14 colour categories) by season (summer vs. winter), with each cell representing the frequency at which a colour was selected as the most desirable in that season. Based on this table, we performed chi-square test of independence to assess whether the distribution of preferences exhibited differences by season. Where significant, we carried out residual analyses to identify the colours that were over- or underrepresented in each season. Residual analysis examined how the observed values in each cell deviated from the expected values.

2.4. Results

2.4.1. Results of desirable sensory attributes in summer and winter

Mixed-design analysis of variance revealed significant main effects of season, $F(1, 572) = 9.96$, $p = .0017$, $\eta^2 = 0.0171$, and sensory attribute, $F(7.01, 4010.09) = 215.96$, $p < .001$, $\eta^2 = 0.2741$. Importantly, the season × sensory attribute interaction was also significant, $F(7.01, 4010.09) = 72.90$, $p < .001$, $\eta^2 = 0.1130$, indicating that the desirability of specific sensory attributes varied by season. Follow-up simple effect analyses revealed that all ten sensory attributes showed statistically significant differences between the summer and winter samples (Fig. 1). The participants judged higher levels of *coolness* and *hardness* to be more desirable in summer than in winter. Participants also judged higher *fattiness, richness, sweetness, custard flavour, smoothness, milkiness, density, and vanilla flavour* to be more desirable in winter than in summer. Statistical summaries of the desirability ratings of the sensory attributes of the ice cream in summer and winter determined using simple effect analyses are presented in Appendix F.

To further explore seasonal patterns in attribute prioritisation, we examined within-season differences using post hoc comparisons (Fig. 2). The results revealed distinct patterns of preference across sensory attributes for each season. In summer, *coolness* was found to be rated significantly higher than all of the other attributes, making it the preferred sensory characteristic. The next highest rated attributes were *smoothness*, *milkiness*, and *richness*, which were statistically indistinguishable from each other, but were significantly higher than *fattiness* and *custard flavour*. *Fattiness* and *custard flavour* received the lowest ratings and did not differ significantly from one another. Conversely, in winter, *richness* was rated the highest, followed by *smoothness* and *milkiness*. These three attributes form the top tier of preferences and significantly exceed the others. At the bottom end, *coolness* and *hardness* were rated significantly lower than most other attributes and did not differ significantly from each other.

2.4.2. Results of desirable ice-cream package colour in summer and winter

To investigate whether the colour preferences for vanilla ice cream packaging differed between seasons, we conducted a chi-square test of independence. A contingency table was constructed to cross-tabulate the participants' preferred package colours (14 colour categories) by season (summer vs. winter), with each cell representing the frequency with which a colour was selected as the most desirable in that season. The chi-square test revealed a highly significant difference in regard to the distribution of colour preferences between summer and winter, $\chi^2(13) = 110.91$, $p < .001$, Cramér's $V = 0.12$, indicating a strong association between season and package colour preference.

To examine the colours that were disproportionately preferred across seasons, we conducted a residual analysis following the chi-square test of independence (Fig. 3). Standardised residuals exceeding ±1.96 were interpreted as statistically significant deviations from expected values, suggesting a preference or avoidance of specific colours in either summer or winter.

In summer, light blue was significantly over-represented ($z = 4.58$), and cream showed a significant positive deviation ($z = 2.24$), indicating a strong preference for these colours during this season. White also exhibited a marginally positive deviation ($z = 1.52$), thus suggesting a possible preference, although this was not found to be statistically

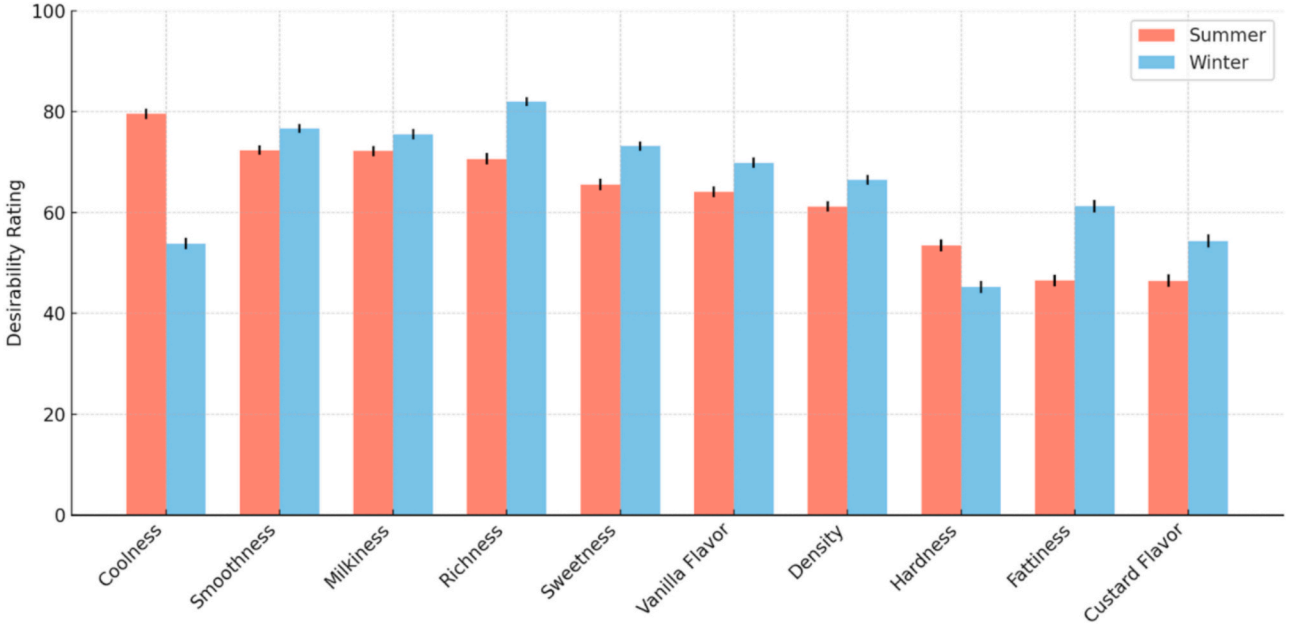

Fig. 1. Desirability ratings of sensory attributes of ice cream: between-season comparison (summer vs. winter).
Note: Ratings were made on a scale of 0 to 100 (0 = not desirable at all; 100 = extremely desirable). Error bars represent standard error of the mean. All of the attributes differed significantly between seasons ($p < .05$).

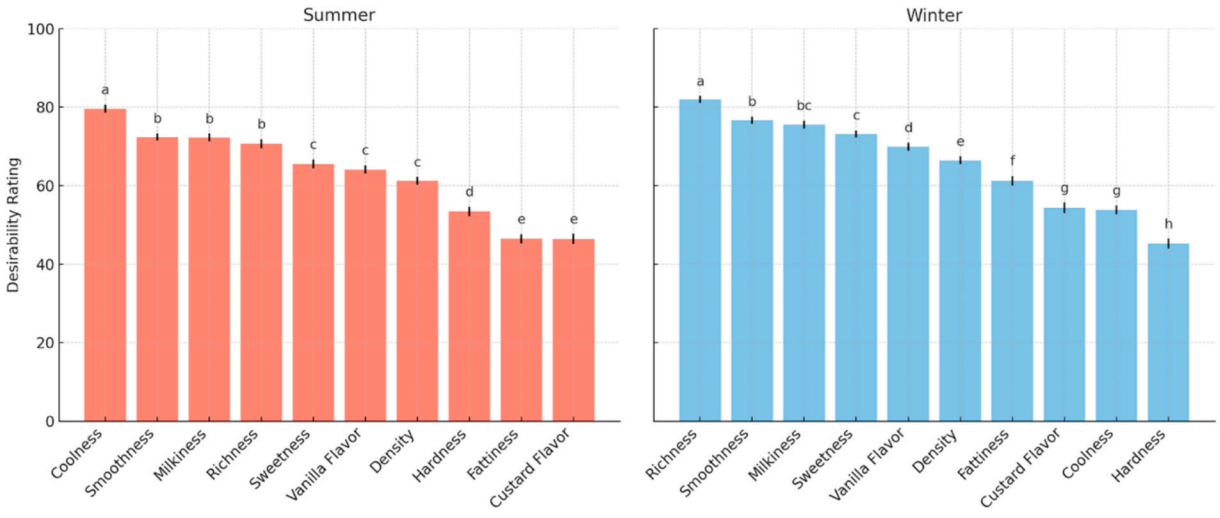

Fig. 2. Desirability ratings of sensory attributes of ice cream: within-season comparison (summer and winter).
Note: Ratings are based on a 0–100 scale ("not desirable at all" to "extremely desirable"). Error bars represent standard error of the mean. Different letters (e.g. a, b, c) indicate statistically significant differences among attributes within each season ($p < .05$, adjusted using Shaffer's modified sequentially rejective Bonferroni procedure; Shaffer, 1986).

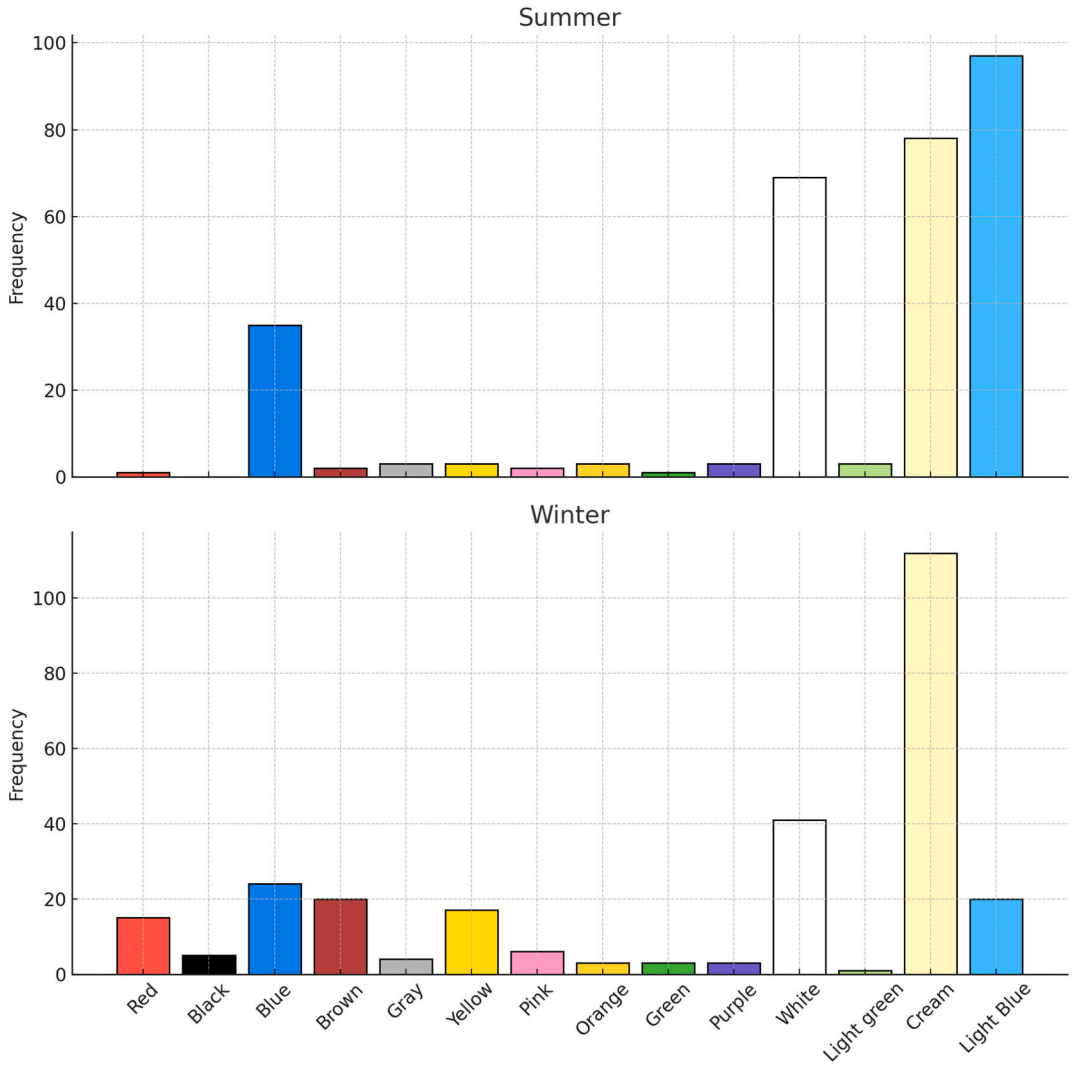

Fig. 3. Preferred package colours for vanilla ice cream across the seasons.
Note: Frequencies reflect participants' selection of the most desirable package colour for vanilla ice cream in each season.

significant. In winter, cream remained significantly preferred ($z = 2.24$), suggesting a consistent appeal across seasons. The yellow ($z = 2.41$) and dark red ($z = 2.93$) lines also show significant positive deviations. Conversely, light blue was significantly underrepresented in winter ($z = -4.80$).

3. General discussion

3.1. Summary of findings

This study has examined how seasonal context influences consumers' desirable food-intrinsic and food-extrinsic sensory attributes of vanilla ice cream. By comparing consumer responses collected during summer and winter, we identified clear seasonal shifts in sensory preferences. Summer participants expressed a stronger desire for attributes associated with cooling, particularly coolness and hardness, whereas winter participants favoured more indulgent qualities such as richness, smoothness, milkiness, and fattiness. In addition, packaging colour preferences varied significantly across seasons. Light blue was especially preferred in summer, but was significantly avoided in winter, highlighting a strong seasonal contrast in its appeal. In contrast, the warmer tones such as dark red and yellow are preferred in winter. Notably, cream was consistently preferred across both seasons. These findings provide converging evidence that the seasonal context dynamically shapes consumer preferences for both desirable food-intrinsic and food-extrinsic sensory attributes.

3.2. Theoretical contributions

Our results contribute to the literature on sensory and consumer sciences in ice cream products. Past research on sensory and consumer science in ice cream has mainly focused on how food-intrinsic factors (e.g. flavour, fat/sugar content) shape sensory profiles and acceptance (e.g., Guinard et al., 1996). While more recent past studies have expanded this focus to include food-extrinsic factors (e.g. typeface and music), these elements have typically been examined without considering seasonal variations (e.g., Otterbring et al., 2022). Our findings extend this body of work by demonstrating that the desirability of food-intrinsic and food-extrinsic sensory cues of vanilla ice cream depends on the season.

The second contribution is that our results advance the understanding of seasonal effects on food consumer behaviour (Tran et al., 2023). Although it is widely acknowledged at an anecdotal level that consumers prefer different products or packaging in different seasons, little empirical research has systematically documented these effects (Boon & Schifferstein, 2022; Spence, 2021). To the best of our knowledge, no prior research has quantitatively examined the specific sensory attributes and packaging cues preferred in different seasons or to what extent these preferences vary, not only for ice cream but also for food and beverages more broadly. Using vanilla ice cream as a representative example, our study demonstrated that such preferences systematically differ between summer and winter.

Our findings contribute to the literature on thermoregulation theory of food intake. Previous research has shown that warmer foods are preferred in cold environments. Colder foods are preferred in warm settings, possibly because of their thermoregulatory requirements (Motoki et al., 2018). We expand on this literature by demonstrating that sensory attributes associated with temperature (e.g. coolness and richness) can influence consumer preferences, even within the same product, depending on the seasonal context. This suggests that thermoregulatory motivations shape not only broad food category preferences (e.g. hot vs. cold dishes), but also more nuanced evaluations of specific sensory characteristics within a given food.

These findings contribute to a growing body of research on temperature-based correspondence (Barbosa Escobar et al., 2023; Motoki et al., 2020; Spence, 2019), particularly in the context of consumer behaviour (Motoki et al., 2019). Colours are commonly associated with temperature (e.g., Fenko et al., 2010), as reflected in the terms "warm" (e.g., red) and "cool" (e.g., blue) colours. Warm- and cool-coloured packaging, along with related visual cues, have been widely employed in consumer behaviour research (e.g., Lin & Au, 2025). In contrast to previous findings showing that congruent visual temperature cues (e.g. red–heat and blue–cold) lead to positive evaluations (Ketron & Spears, 2020), our results have revealed that incongruent packaging (i.e. cool-coloured packaging in summer) is preferred over congruent packaging (i.e. warm-coloured packaging in summer) for ice cream products. This suggests that incongruent colour–temperature cues, such as cool-coloured packaging for cold foods, may enhance product appeal in certain contexts, particularly during hot weather.

The present study also revealed that certain attributes remained consistently preferred across seasons. Smoothness and milkiness received high desirability ratings in both summer and winter. Similarly, cream-coloured packaging maintained a consistently high level of preference, regardless of the season. One possible explanation for this consistent preference is that cream-coloured packaging may visually resemble the appearance of the vanilla ice cream itself. Colours often represent specific foods and flavours (e.g., red–tomato, green–cucumber; (Wan et al., 2014). Previous research has shown that consumers tend to prefer packaging colours that are congruent with the actual colour of a product (Huang & Wan, 2019). These findings suggest that such attributes may represent core sensory characteristics and packaging design features that are valued independent of the seasonal context. From a product development perspective, ensuring a smooth and milky texture and offering cream-toned packaging may be universally important for fostering positive consumer evaluations of vanilla ice cream throughout the year.

3.3. Practical contributions

Our findings offer practical insights for ice cream marketers and designers. First, the results highlighted the importance of tailoring product attributes to satisfy seasonal consumer expectations. For instance, promoting ice cream formulations with enhanced cooling properties and firmer textures may be particularly effective in summer, whereas emphasising richness and creaminess may align better with consumer preferences in winter. Secondly, our findings underscore the need for seasonally adapted packaging strategies. Consumers' packaging colour preferences were found to have shifted markedly between seasons, favouring cool-toned designs such as light blue and cream in summer and warm-toned or creamy hues such as dark red and yellow in winter. This study illustrates the potential benefits of adopting seasonally appropriate sensory marketing strategies to align season-specific preferences for desirable sensory attributes.

Notably, seasonal variation emerged not only in sensory preferences, but also in preferences for packaging colours. This result suggests that consumers respond positively to seasonally adaptive packaging designs, thereby enhancing their preferences at different times of the year. Although such strategies may appear to conflict with traditional marketing principles that emphasise brand consistency, they may reflect a more context-sensitive approach to consumer preferences. This perspective aligns with recent discussions by Boon and Schifferstein (2022), who propose using seasonality not only as a creative inspiration for food design but also as a business strategy to align products with consumers' shifting preferences across the year.

3.4. Limitations and future research

This study focused solely on vanilla ice cream because of its global popularity. Although seasonal flavour offerings are often observed in the commercial ice cream market (e.g. citrus flavours in summer and chocolate in winter), to the best of our knowledge, variations in consumer flavour preferences have not been evaluated in empirical academic research. For example, consumers may favour refreshing options

such as lemon in summer, whereas richer flavours such as chocolate may be more appealing in winter. This lack of empirical evidence contrasts with conceptual work that highlights the potential of seasonality to guide flavour-based food design (Boon & Schifferstein, 2022), as well as multisensory strategies for conveying meaning and creating experiences through flavour (Schifferstein et al., 2022).

Another limitation is that this study examined only two seasons, summer and winter, and excluded spring and autumn. These seasons were intentionally selected because they represent the most climatically contrasting periods of the year and because summer is typically the peak season for ice cream consumption. However, it still remains unknown whether specific sensory attributes are uniquely preferred in spring and autumn or whether preferences in these seasons align more closely with those observed in summer or winter. Beyond thermoregulation, the connotations evoked by different seasons may shape how consumers evaluate sensory attributes. For example, as spring may symbolise freshness, renewal, and new beginnings, lighter and smoother textures and pastel packaging colours may be preferred during this season. In autumn, richer and denser textures and deeper and warmer packaging hues (e.g. burgundy and olive green) may be more desirable, reflecting seasonal associations such as harvest, depth, and cosiness. Future research should explore how sensory expectations and evaluations shift across all four seasons, offering a more nuanced understanding of seasonal influences on food expectations.

Another limitation concerns the interpretation of packaging colour preferences. In the current study, the participants were asked to select their preferred packaging colour from a set of swatches without distinguishing between the background colour of the packaging and the colour of the ice cream product depicted within it. Prior research revealed that background colour can influence food evaluation (e.g., Howell & Schifferstein, 2019; Schifferstein et al., 2017). Although this approach does not allow for strict separation of these two visual elements, the observed colour preferences suggest a possible combination of the preferred background and ice cream colours. For example, the frequent selection of light blue and cream in summer may indicate that the participants preferred packaging designs featuring a light blue background paired with cream-coloured ice cream. However, because these elements were not independently evaluated, it still remains uncertain whether the preference was driven primarily by the background colour, product colour, or their combination. Future studies should assess ideal background and product colours separately.

Finally, this study relied on stated preference measures, which may not fully capture actual consumer behaviour. Although this approach is commonly used in sensory and consumer research, future studies should examine whether the identified seasonal preferences for sensory attributes and packaging colours influence real-world behaviours such as product choice or purchase. Moreover, we employed a between-participants design, with separate samples surveyed in summer and winter. Although this approach is widely used in seasonal research (e.g., Seo et al., 2009), it does not track how the preferences of the same individual change from summer to winter. Although the two samples were matched for key demographic variables (e.g. age, gender), future studies could adopt a within-participants design to examine individual-level seasonal changes in consumer preferences more directly.

CRediT authorship contribution statement

Kosuke Motoki: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Reiko Kuroda:** Writing – review & editing, Methodology, Conceptualization. **Eriko Sugai:** Writing – review & editing, Methodology, Conceptualization. **Akihito Miura:** Writing – review & editing, Methodology. **Youko Ichimasa:** Writing – review & editing, Methodology, Conceptualization. **Yuki Yagi:** Writing – review & editing, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2025.105658.

Data availability

Data will be made available on request.

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