International Journal of Food Studies | IJFS April 2023 | Volume 12 | pages 123–131

# Effect of Fish Gelatin on the Characteristics of Horn Plantain Banana (*Musa paradisíaca fa. Corniculata*)-based Ice Cream

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Received: 25 December 2022; Published online: 18 April 2023

**Abstract**

Ice cream is a frozen dairy product that includes healthy and nutritious aspects. To improve the value of the health benefits, it is necessary to develop functional ice cream products. One such addition is horn plantain bananas, which have the benefit of having a high dietary fibre and pectin content. In order to make ice cream, gelatin must be used as a stabilizer. The increase of non-halal gelatin has led to improvements in the production of halal gelatin derived from fish. This study was performed to evaluate the effect of adding fish gelatin to the characteristics of plantain banana (*Musa paradisiaca fa. Corniculata*)-based ice cream. This study used a pre-experimental design with a fully randomized design and one component, the addition of varying quantities of fish gelatin (A1: 0 %, A2: 0.25 %, and A3: 0.5 %) with three replicates. The characteristics (taste, fragrance, texture, and colour), melting time, and overrun were evaluated. The Duncan Multiple Range Test as post-hoc test was used to continue ANOVA-based data analysis. The results demonstrated that the inclusion of fish gelatin at various levels did not significantly alter the degree of preference for colour, fragrance, flavour, or overrun. Texture and melting time were different ($p < 0.05$). According to this study, the ice cream that the panellists preferred had an average overrun value of 52.67 ± 9.87, a melting time of 26.0 ± 0.1 minutes, and was made using the A3 formulation with 0.5 % fish gelatin.

***Keywords:*** Ice cream; Horn Plantain Banana; Fish Gelatin

## 1 Introduction

Banana is one of the tropical fruit products in Indonesia that has the potential to contribute to food diversification. Bananas are one of the agricultural products with a high nutritional value but a high susceptibility to harm. The horn plantain banana is a regularly encountered and frequently consumed kind of banana (*Musa paradisiaca fa. Corniculata*) (Yangilar, 2015). The high concentration of nutritional fibre, pectin, and native resistant starch is a benefit of horn plantain bananas (Ghag & Ganapathi, 2019; Kavitha & Aparna, 2021; Li et al., 2020; Nguyen & Nguyen, 2022; Phillips et al., 2021; Safdari et al., 2021; Udo et al., 2021). Horn plantain banana contains a relatively high amount of starch and amylose, allowing it to be further developed as a functional meal. The food fibre content of horn plantain banana is 2.3 g/100 g (Octavia et al., 2017). Moreover, plantains contain fructo-oligosaccharides (FOS), which are beneficial prebiotics for the digestive system. There is 6.08 % FOS in processed horn plantain bananas. Due to the fact that plantains are included in the plantain family, horn plantain bananas have a

 10.7455/ijfs/12.1.2023.a9

higher carbohydrate content than other varieties of bananas, making them suitable for ice cream recipes (Jenie et al., 2012).

Ice cream is a frozen product used as a dessert and made from emulsified dairy ingredients, sweeteners (sucrose or dextrose), and stabilizers (Clarke, 2012; Feizi et al., 2021; Syed & Shah, 2016). Based on Indonesian Euromonitor data, retail sales of ice cream and frozen desserts in Indonesia reached US$425 million in 2021 (Euromonitor International, 2022) rising by 0.24 % from the previous year when it was worth US$424 million. This is the largest of the last five years. Food sales have been observed to have increased since the Covid-19 pandemic in 2020 (Euromonitor International, 2022). Ice creams are a rich source of fat, carbohydrates, and protein, which reflects its energy value. The energy value of standard ice cream is almost 200 kcal/100 g (Legassa, 2020). The consumer awareness of functional and healthier dairy has led to the development of new methods to produce ice cream. Ice cream is a sort of cuisine that is liked by consumers of all ages, from toddlers to adults, due to its delectable, sweet flavour and creamy consistency. Ice cream is a form of frozen cuisine created by freezing a mixture of pasteurized and homogenised milk products, sugar, stabilizers, emulsifiers, and other additives (Ntau et al., 2021). The production of ice cream requires a small quantity of gelatin stabilizer to preserve the emulsion and enhance its softness (Deosarkar et al., 2016; Istiqomah et al., 2017). Therefore, the addition of stabilizer to ice cream is necessary to produce ice cream with a soft texture, which can improve the aeration of the ice cream, reduce ice crystals growth during storage, controlling melting down, and provide uniformity of product (Bahramparvar & Tehrani, 2011; Syed & Shah, 2016). Commonly used stabilizers for ice cream are gelatin, guar gum, locust gum, alginate, carrageenan, pectin, carboxymethyl cellulose (CMC), and crystalline micro cellulose (Ayudiarti, Hastarini, & Susilowati, 2020; Ayudiarti, Suryanti, & Oktavia, 2020; Pirsa & Hafezi, 2023).

Stabilizers promote good melting of the ice cream, and provide a good texture when consumed. The best stabilizer should be harmless, readily dispersed in the ice cream, not give high viscosity and melting, be inexpensive and affordable, and not provide additional flavours (must be neutral taste) to the product (Goff & Hartel, 2013; Kamińska-Dwórznicka et al., 2022; Lestari et al., 2019; Murtaza et al., 2004; Regand & Goff, 2002). The amount and type of stabilizer used in ice cream depends on its profile. One of stabilizers used in ice cream is gelatin, because gelatin nearly tasteless and odourless with a colourless or slightly yellow appearance, so its characteristic will not affect the sensory quality of ice cream. Gelatin is a polypeptide derived from the hydrolysis of animal skin or bone collagen (Ahmad et al., 2021; Gómez-Guillén et al., 2011; See et al., 2015). The quantity of annual imports demonstrates that the demand for gelatin is growing in Indonesia. The skin and bones of cattle or pigs are used to create the raw material for imported gelatin. The utilization of raw materials derived from pig will be a difficulty for the majority-Muslim population of Indonesia, while those derived from beef will pose a problem for individuals who do not consume meat due to religious beliefs. This underpins the production of gelatin generated from fish bones and skin so that the raw materials are halal, sanitary, and acceptable to followers of other religions. The production of fish gelatin simultaneously disposes of fish fillet scraps, and the fish gelatin processing industry may be expanded to achieve high economic value and industrial competitiveness in the fisheries industry (Coppola et al., 2021; Ntau et al., 2021). Gelatin extracted from fish scale and skin is a biopolymer that contains protein up from 85% to 92%, water, and mineral salt (Alipal et al., 2021; Choi & Regenstein, 2000; Duconseille et al., 2015; Gómez-Guillén et al., 2002; Karim & Bhat, 2009).

Recent study in Indonesia, developing fish gelatin had been conducted using corkfish (*Channa striata*) (Ayudiarti, Hastarini, & Susilowati, 2020), tuna fish (Ayudiarti, Suryanti, & Oktavia, 2020), catfish (Alika & Atma, 2018), milkfish (*Chanos chanos*) (Swastawati et al., 2022), and other fish (Lestari et al., 2019). Gelatin made from these fish bones and skin has the potential to be used as a stabilizer. In addition to producing halal gelatin products at a relatively low price making it affordable, the utilization of these two raw materials can also reduce food waste, especially fish waste. Thus, the utilization of fish by-products plays an important role in economic growth and sustainable development. Studies related to the effect of adding fish gelatin as a stabilizer on the characteristics and sensory quality of banana-based ice cream are still highly limited. Therefore, this study aimed to determine the concentration of fish gelatin addition to horn plantain banana (*Musa paradisiaca fa. Corniculata*)-based ice cream and determine the characteristics and sensory quality of banana based-ice cream added with fish gelatin as a stabilizer.

## 2 Materials and Methods

The time frame for this research was from July to November 2022. The ice cream was made in the Nutrition Laboratory, Faculty of Health Sciences, Singaperbangsa Karawang University. The research had passed the ethical test with number 0922-09.022 /DPKE-KEP/FINAL-EA/UEU/IX/2022.

### 2.1 Tools, Materials, and Ice Cream Making Process

The tools needed to make catfish bone gelatin included basins, knives, pans, digital balances (Mettler Toledo), glass jars, aluminum foil, filters, beakers, calico fabric, and water baths. The tools used in making ice cream were blenders (HR2102/00, Philips, China), mixers (HR 1538/83, Philips, Indonesia), ice cream makers (ICE-1530, GEA, China), gas stoves (RI-603, Rinnai, Indonesia), spoons, thermometers (CHC445, Chenghi, China), freezer (GN-INV304SL, LG, Indonesia), pots, wooden spatulas.

The banana ice cream was made following the procedure described by Ntau et al. (2021) with modifications. The plantains, skim milk, sugar, and fish gelatin required to make plantain ice cream purchased at the local market in Karawang. Horn plantains weighed up to 500 g; fish gelatin was weighed for each treatment A1 : 0 g, A2 : 1.25 g (0.25 %), A3 : 2.5 g (0.5 %), Sugar 75 g. Non-dairy cream 100 g. Treatment A1 substituted 0.25 % carboxyl methyl cellulose (CMC), (1.25 g) for the fish gelatin. CMC was obtained from the Gunacipta Multirasa Company, Indonesia. After mixing, the mix was pasteurized for 30 minutes at 60 $^{o}$C. It was then cooked and stirred for a further 30 minutes. After being poured into the designated basin, the liquid was allowed to cool for 5 minutes at room temperature. It was then elatina in the freezer for the first time for 4 hours. After this time it was removed, and the ice cream was broken up with a spoon, then homogenized using a mixer that had been set to switch number 3 for 15 minutes. It was placed in the freezer for a second time for four hours before the second homogenization. The second homogenization was carried out at the same speed setting and time as before. The ice cream mixture was then sealed in a container and frozen for 24 hours.

#### Analysis

This research used a pre-experimental design with a totally randomized design and one factor, the addition of varying amounts of fish elatina (A1:0 %, A2:0.25 %, and A3:0.5 %) with three repeats. The ice cream was tested for liking (taste, scent, texture, and colour), melting time, and overrun. The liking testing was undertaken by 35 qualified undergraduate nutrition students. The ANOVA data analysis was followed by a Duncan Multiple Range Test to determine where the significant elatina s were.

## 3 Results and Discussion

### 3.1 hedonic Test (Sensory Quality)

#### Colour

The addition of various concentrations of fish elatina to the colour of plantain ice cream did not significantly alter the colours of A1, A2, or A3 ($p>0.05$) (Table 1). The mean score of the colour parameter was between 3.80 and 4.17, as shown in Table 1 of the hedonic test findings. Therefore it was inferred that the panellists liked the manufactured ice cream items moderately to very much. These result was similar to study performed by Alika and Atma (2018). They reported that the mean score of the colour parameter of ice cream with the addition of 1.2 % fish gelatin in ice cream is 3.66 and the score of hedonic test of ice cream colour was 'like slightly'. Another study performed by Ayudiarti, Suryanti, and Oktavia (2020) reported that the highest score of the colour parameters is shown by ice cream using 0.4 % fish gelatin.

Panellists favoured ice cream prepared with non gelatin because the white hue of CMC made the ice cream more vibrant than ice cream made with gelatin. Fish gelatin dissolved in water has a hazy brown hue, whereas the CMC stabilizer becomes transparent when dissolved in water, resulting in a greater degree of clarity than gelatin. The pigment from the fish skin, which has not entirely dissipated, causes the hue of the ice cream to become darker with increasing gelatin concentration (Abdel-Maqsoud et al., 2021). Product appearance, such as the colour, is a crucial attribute in consumer choice because they tend to consider the appearance more than other sensory attributes. This is because a product with a good appearance tends to be considered to have a good taste and good quality.

### Aroma

There was no significant difference between A1, A2, and A3 ($p>0.05$) with regard to the scent of horn plantain banana ice cream made with fish gelatin (Table 1). The hedonic testing (Table 1) revealed that the mean score of the aroma parameter ranged from 3.71 to 3.83, with the greatest average value occurring in A1. Significantly, the typical treatment has about the same score in the category of liking the ice cream aroma. The plantain scent was more prominent than that of the added gelatin. CMC and fish gelatin do not contain volatile components, therefore they have little impact on the scent of food products to which they are added. Gelatin treatment had no effect on the aroma of ice cream, because the gelatin is tasteless and flavourless. Therefore, the smell of fish gelatin was not detected by the panellists (Regand & Goff, 2002). In a study by Swastawati et al. (2022) they reported that using 0.7 % of fish gelatin has the highest score, with a significant difference of $p\leq0.05$, whereas Ayudiarti, Suryanti, and Oktavia (2020) showed that ice cream with 0.5 % fish gelatin had the highest aroma score.

### Flavour

There was no statistically significant difference ($p>0.05$) between A1, A2, and A3 in the flavour of horn plantain banana ice cream with fish gelatin (Table 1). Since gelatin merely serves as an emulsifier and has the properties of being tasteless and odourless, using fish gelatin as a stabilizer has no impact on the flavour of ice cream. The formula used for this research was not based on milk and bananas, but rather on the amount of stabilizer that was added to provide a fairly consistent sweet flavour. The use of fish gelatin as a stabilizer has no effect on the taste of ice cream because gelatin only acts as an emulsifier, and the characteristics of gelatin are that it is tasteless and odourless. Flavour in ice cream must be detected easily and provide refreshing taste in all conditions. The formula devised in this study was not based on the banana and milk content, but on the concentration of the stabilizer used so as to provide a relatively uniform sweet taste (Syed et al., 2018). Swastawati et al. (2022) showed that the flavour score with 0.7 % fish gelatin addition had the highest value and also had significant difference ($p<0.05$) from other gelatin additions. In addition, Ayudiarti, Suryanti, and Oktavia (2020) reported that the highest flavour score was given by ice cream using 0.1 % tuna gelatin while the lowest score was given by ice cream using 0.3% tuna gelatin. However the results of a Kruskall Wallis analysis of flavour parameters showed no significant difference ($p<0.05$) between treatments.

### Texture

There was a considerable difference between A1 and A2, and A1 and A3 on the texture of plantain ice cream with the addition of fish gelatin (Table 1). In contrast, the addition of fish gelatin to A2 and A3 had no discernible effect on the texture of plantain ice cream. According to Table 1 of the hedonic testing, the average texture value fell between the range of 3.43 to 4.14, with A2 having the highest average value.

The consistency of ice cream is affected by the

Table 1: Hedonic Testing (sensory)

| Parameter | A1 | A2 | A3 | p |
|---|---|---|---|---|
| Colour | $4.17 \pm 0.785^a$ | $3.94 \pm 0.639^a$ | $3.80 \pm 0.632^a$ | 0.08 |
| Aroma | $3.83 \pm 0.785^a$ | $3.80 \pm 0.797^a$ | $3.71 \pm 0.926^a$ | 0.839 |
| Flavour | $4.06 \pm 0.838^a$ | $3.60 \pm 0.946^a$ | $3.94 \pm 0.906^a$ | 0.091 |
| Texture | $3.43 \pm 0.815^a$ | $3.94 \pm 0.765^b$ | $4.14 \pm 0.810^b$ | 0.001 |

Note:
Values are presented as means ± standard deviation. Values with different superscript small letters on the same line differ significantly ($p<0.05$).
Scale: 1.01-2.00 = really dislike; 2.01 - 3.00 = dislike; 3.01 - 4.00 = somewhat like ; 4.01 - 5.00 = like; 5.01 - 6.00 = really like.

size of ice crystals, fat globules, air bubbles, and lactose crystals. The soft texture of ice cream is heavily determined by the composition of the stabilizer, the processing methods employed, and the storage conditions. In this study, respondents favoured ice cream with fish gelatin. This was due to the greater capacity of gelatin to bind water than CMC and its lack of syneresis, which resulted in a comparatively smoother texture of ice cream. In addition to providing products with the best adherence, these functional qualities are crucial for making goods with a pleasing texture (Feizi et al., 2021).

## 3.2 Overrun and melting time of ice cream

### Overrun

This is the overflowing or expanding volume of the ice cream, as air is trapped in it during mixing. Air spaces will be created throughout the agitation process, and these will be released when the ice melts. Ice cream with a snowy texture will be produced as the overrun rises (spongy). The Indonesian National Standard states that the proportion of overrun for high-quality ice cream is roughly 70–80 %, compared to 50–70 % for small-scale ice cream production and 35–50 % for domestic production. The amount of stabilizer added will also affect overrun. Too much stabilizer causes the mix to become thick and tough to expand, and it is difficult for air to be incorporated into the mix.

There was no statistically significant difference ($p>0.05$) between the three ice cream formulations (Table 2). The composition A3 with 0.5 % fish gelatin had the greatest overrun percentage. This is agreed with studies conducted by Soad et al. (2014) Compared to ice cream with konjac stabilizer (66.70 %) and carrageenan (46.99 %) without the addition of emulsifier, ice cream with 0.5% gelatin stabilizer without the addition of emulsifier generated a greater overrun (77.29 %). According to El-Sisi (2014), ice cream stabilized with gelatin tends to exhibit more overrun than ice cream stabilized with chitosan.

As indicated above, one of the tasks of the stabilizer is to increase the overrun value (Bahramparvar & Tehrani, 2011). Gelatin has the characteristic of creating more overrun (Arbuckle, 1986). Gelatin is a protein stabilizer (Goff & Hartel, 2013). and is composed of both hydrophilic and hydrophobic amino acids. The hydrophilic segment binds water, whereas the hydrophobic segment attaches to air. During the process of air incorporation, it is the air that creates bubbles. A portion of the hydrophobic region will absorb surface water.

### Melting Time

There are several impacts of fish gelatin on the quality of ice cream, one of which was shown in a study by Ayudiarti, Suryanti, and Oktavia (2020), in which tuna fish gelatin was used in ice cream. The inclusion of tuna fish gelatin gave a

Table 2: Overrun and melting time of ice cream

| | A1 | A2 | A3 | p |
|---|---|---|---|---|
| Overrun (%) | 46.0 + 3.46[a] | 51.33 + 5.03[a] | 52.67 + 9.87[a] | 0.07 |
| Melting time (minutes) | 26.0 + 0.1[a] | 25.67 + 0.57[a] | 20.33 + 1.15[b] | 0.001 |

Note:
The one way Anova test was followed by *Duncan Multiple Range Test* (DMRT)
Values are presented as means ± standard deviation. Values with different superscript small letters on the same line differ significantly ($p<0.05$).

lower melting rate compared to beef gelatin. It was discovered in that investigation that tuna fish gelatin had a stronger viscosity and gel strength, resulting in a lower overrun value. The low overrun value boosts the resistance to melting of the ice cream.
There was a statistically significant difference ($p<0.05$) in the melting times of the three formulations as shown in Table 2. The formula without the addition of A1 gelatin had a longer melting time than the version with fish gelatin. The purpose of the stabilizer is to produce a gel in water or to combine with water so as to prevent excessive melting. In addition to the stabilizer, fat destabilization/agglomeration, viscosity, and ice crystal size influence the melting rate. Fat destabilization takes the form of clumps of fat globules that coat and encircle the air. The rise in fat clumps will increase resistance to the flow of serum (water-soluble material) as it melts and reduce the melting rate (Muse & Hartel, 2004). The hydrophobic amino acid content of African catfish bone gelatin was higher than the hydrophilic content. Therefore, the gelatin protein binds fat more strongly, reducing fat instability by making it more difficult for fat globules to comine with one another (coalescence). However, when the concentration of gelatin increases, so does the amino acid content, the amount of water bound by protein, and the total solids, causing the viscosity to increase. The melting rate of ice cream falls as the size of the ice crystals decreases (Alfaro et al., 2014).

## 4 Conclusions

The quantity of fish gelatin in the horn plantain banana ice cream increased the overrun value. This was inversely related to the rate of melting: the more gelatin that was added, the quicker the rate of melting. According to this study, the ice cream that the panellists preferred had an average overrun value of 52.67 + 9.87, a melting time of 26.0 + 0.1 minutes, and was made using the A3 formulation with 0.5 % fish gelatin. Higher concentrations of fish gelatin had no effect on the preferences of panellists for the colour, aroma, or flavour, but boosted their preference for texture. Their texture preference ranged from 'like slightly' to 'like'.

## Acknowledgements

The author would like to thank the Institute of Research and Community Service (LPPM) of Universitas Singaperbangsa Karawang for providing full support and financing to ensure the success of this research project.

## References

Abdel-Maqsoud, N., Elshaghabee, F., Metwally, A., & Anis, S. (2021). Impact of nano-stabilizers on the technological, texture and rheological properties of ice cream. *Egyptian Journal of Chemistry*, *65*(6), 283–291. https://doi.org/10.21608/ejchem.2021.102692.4761

Ahmad, T., Ismail, A., Ahmad, S. A., Khalil, K. A., Awad, E. A., Akhtar, M. T., & Sazili, A. Q. (2021). Recovery of gelatin from bovine skin with the aid of pepsin and its effects on the characteristics of the extracted gelatin. *Polymers*, *13*(10), Article 1554. https://doi.org/10.3390/polym13101554

Alfaro, A. T., Biluca, F. C., Marquetti, C., Tonial, I. B., & Souza, N. E. d. (2014). African catfish (*Clarias gariepinus*) skin gelatin: Extraction optimization and physical–chemical properties. *Food Research International*, *65*(Part C), 416–422. https://doi.org/10.1016/j.foodres.2014.05.070

Alika, V. A., & Atma, Y. (2018). The organoleptic and physicochemical characteristic of gelato by fish bone gelatin addition [Number: 1]. *Journal of Applied Sciences and Advanced Technology*, *1*(1), 31–38. https://doi.org/10.24853/jasat.1.1.31-38

Alipal, J., Pu'ad, N. A. S. M., Lee, T. C., Nayan, N. H. M., Sahari, N., Basri, H., Idris, M. I., & Abdullah, H. Z. (2021). A review of gelatin: Properties, sources, process, applications, and commercialisation. *Materials Today: Proceedings*, *42*(Part 1), 240–250. https://doi.org/10.1016/j.matpr.2020.12.922

Arbuckle, W. S. (1986). *Ice cream*. Springer. https://doi.org/10.1007/978-1-4757-5447-6

Ayudiarti, D. L., Hastarini, E., & Susilowati, R. (2020). Physical characteristics of gelatin from cork fish skin in the waters of Merauke. *E3S Web of Conferences*, *147*, Article 03027. https://doi.org/10.1051/e3sconf/202014703027

Ayudiarti, D. L., Suryanti, & Oktavia, D. A. (2020). The effect of different types and gelatin concentrations on ice cream quality [Publisher: EDP Sciences]. *E3S Web of Conferences*, *147*, Article 03026. https://doi.org/10.1051/e3sconf/202014703026

Bahramparvar, M., & Tehrani, M. M. (2011). Application and functions of stabilizers in ice cream. *Food Reviews International*, *27*(4), 389–407. https://doi.org/10.1080/87559129.2011.563399

Choi, S.-S., & Regenstein, J. M. (2000). Physicochemical and sensory characteristics of fish gelatin. *Journal of Food Science*, *65*(2), 194–199. https://doi.org/10.1111/j.1365-2621.2000.tb15978.x

Clarke, C. (2012). *The science of ice cream* (2nd ed.) [OCLC: 1090180033]. Royal society of chemistry. https://doi.org/10.1039/9781839168512

Coppola, D., Lauritano, C., Palma Esposito, F., Riccio, G., Rizzo, C., & de Pascale, D. (2021). Fish waste: From problem to valuable resource [Number: 2 Publisher: Multidisciplinary Digital Publishing Institute]. *Marine Drugs*, *19*(2), Article 116. https://doi.org/10.3390/md19020116

Deosarkar, S. S., Kalyankar, S. D., Pawshe, R. D., & Khedkar, C. D. (2016). Ice cream: Composition and health effects. In B. Caballero, P. M. Finglas, & F. Toldrá (Eds.), *Encyclopedia of Food and Health* (pp. 385–390). Academic Press. https://doi.org/10.1016/B978-0-12-384947-2.00385-8

Duconseille, A., Astruc, T., Quintana, N., Meersman, F., & Sante-Lhoutellier, V. (2015). Gelatin structure and composition linked to hard capsule dissolution: A review. *Food Hydrocolloids*, *43*, 360–376. https://doi.org/10.1016/j.foodhyd.2014.06.006

El-Sisi, A. S. (2014). Impact of replacement of gelatin with chitosan on the physicochemical properties of ice-milk. *International Journal of Dairy Science*, *10*(1), 36–43. https://doi.org/10.3923/ijds.2015.36.43

Euromonitor International. (2022). *Ice cream in Indonesia* (tech. rep.). Euromonitor International. Indonesia. https://www.euromonitor.com/ice-cream-in-indonesia/report

Feizi, R., Goh, K. K. T., & Mutukumira, A. N. (2021). Effect of chia seed mucilage as stabiliser in ice cream. *International Dairy Journal*, *120*, Article

105087. https://doi.org/10.1016/j.idairyj.2021.105087

Ghag, S. B., & Ganapathi, T. R. (2019). Banana and plantains: Improvement, nutrition, and health. In J.-M. Mérillon & K. G. Ramawat (Eds.), *Bioactive Molecules in Food* (pp. 1755–1774). Springer. https://doi.org/10.1007/978-3-319-78030-6_73

Goff, H. D., & Hartel, R. W. (2013). *Ice cream*. Springer. https://doi.org/10.1007/978-1-4614-6096-1

Gómez-Guillén, M. C., Giménez, B., López-Caballero, M. E., & Montero, M. P. (2011). Functional and bioactive properties of collagen and gelatin from alternative sources: A review. *Food Hydrocolloids*, *25*(8), 1813–1827. https://doi.org/10.1016/j.foodhyd.2011.02.007

Gómez-Guillén, M. C., Turnay, J., Fernández-Díaz, M. D., Ulmo, N., Lizarbe, M. A., & Montero, P. (2002). Structural and physical properties of gelatin extracted from different marine species: A comparative study. *Food Hydrocolloids*, *16*(1), 25–34. https://doi.org/10.1016/S0268-005X(01)00035-2

Istiqomah, K., Praptiningsih, Y., & Windrati, W. S. (2017). Karakterisasi es krim edamame dengan variasi jenis dan jumlah penstabil. *Jurnal Agroteknologi*, *11*(2), 139–147. https://doi.org/10.19184/j-agt.v11i02.6522

Jenie, B. S. L., Putra, R. P., & Kusnandar, F. (2012). Fermentasi kultur campuran bakteri asam laktat dan pemanasan otoklaf dalam meningkatkan kadar pati resisten dan sifat fungsional tepung pisang tanduk (*Musa paradisiaca formatypica*) [Publisher: Indonesian Ministry of Agriculture]. *Jurnal Penelitian Pascapanen Pertanian*, *9*(1), 18–26. https://doi.org/10.21082/jpasca.v9n1.2012.18-26

Kamińska-Dwórznicka, A., Łaba, S., & Jakubczyk, E. (2022). The effects of selected stabilizers addition on physical properties and changes in crystal structure of whey ice cream. *LWT*, *154*, Article 112841. https://doi.org/10.1016/j.lwt.2021.112841

Karim, A. A., & Bhat, R. (2009). Fish gelatin: Properties, challenges, and prospects as an alternative to mammalian gelatins. *Food Hydrocolloids*, *23*(3), 563–576. https://doi.org/10.1016/j.foodhyd.2008.07.002

Kavitha, V., & Aparna, G. (2021). A review on banana fiber and its properties. *Asian Journal of Pharmaceutical Research and Development*, *9*(3), 118–121. https://doi.org/10.22270/ajprd.v9i3.956

Legassa, O. (2020). Ice cream nutrition and its health impacts [Publisher: Ommega Internationals]. *International Journal of Food and Nutritional Science*, *7*(1), 19–27. https://doi.org/10.15436/2377-0619.20.2678

Lestari, L. A., Wildiana, R. A., Nisa', F. Z., Erwanto, Y., & Pranoto, Y. (2019). Physical, chemical, and sensory properties of ice cream with the substitution of stabilizer with gelatin from various sources. *Journal of Food and Pharmaceutical Sciences*, *7*(3), 166–172. https://doi.org/10.22146/jfps.702

Li, M.-C., Chou, C.-F., Hsu, S.-C., & Lin, J.-S. (2020). Physicochemical characteristics and resistant starch of different varieties of banana from Taiwan. *International Journal of Food Properties*, *23*(1), 1168–1175. https://doi.org/10.1080/10942912.2020.1788077

Murtaza, M. A., Din, G. M. U., Huma, N., Shabbir, M. A., & Mahmood, S. (2004). Quality evaluation of ice cream prepared with different stabilizers/emulsifier blends. *International Journal of Agriculture And Biology*, *6*(1), 65–67.

Muse, M. R., & Hartel, R. W. (2004). Ice cream structural elements that affect melting rate and hardness. *Journal of Dairy Science*, *87*(1), 1–10. https://doi.org/10.3168/jds.S0022-0302(04)73135-5

Nguyen, T. A., & Nguyen, T. H. (2022). Study on mechanical properties of banana fiber-reinforced materials poly (Lactic Acid) composites [Publisher: Hindawi]. *International Journal of Chemical Engineer-*

*ing*, *2022*, Article e8485038. https://doi.org/10.1155/2022/8485038

Ntau, E., Djarkasi, G. S. S., & Lalujan, L. E. (2021). Pengaruh penambahan gelatin terhadap kualitas fisik es krim sari jagung manis [Number: 1]. *Sam Ratulangi Journal of Food Research*, *1*(1), 10–19.

Octavia, Z. F., Djamiatun, K., & Suci, N. (2017). Pengaruh pemberian yogurt sinbiotik tepung pisang tanduk terhadap profil lipid tikus sindrom metabolik [Number: 4]. *Jurnal Gizi Klinik Indonesia*, *13*(4), 159–169. https://doi.org/10.22146/ijcn.19369

Phillips, K. M., McGinty, R. C., Couture, G., Pehrsson, P. R., McKillop, K., & Fukagawa, N. K. (2021). Dietary fiber, starch, and sugars in bananas at different stages of ripeness in the retail market [Publisher: Public Library of Science]. *PLoS ONE*, *16*(7), Article e0253366. https://doi.org/10.1371/journal.pone.0253366

Pirsa, S., & Hafezi, K. (2023). Hydrocolloids: Structure, preparation method, and application in food industry. *Food Chemistry*, *399*, Article 133967. https://doi.org/10.1016/j.foodchem.2022.133967

Regand, A., & Goff, H. D. (2002). Effect of biopolymers on structure and ice recrystallization in dynamically frozen ice cream model systems. *Journal of Dairy Science*, *85*(11), 2722–2732. https://doi.org/10.3168/jds.S0022-0302(02)74359-2

Safdari, Y., Vazifedoost, M., Didar, Z., & Hajirostamloo, B. (2021). The effect of banana fiber and banana peel fiber on the chemical and rheological properties of symbiotic yogurt made from camel milk [Publisher: Hindawi]. *International Journal of Food Science*, *2021*, Article e5230882. https://doi.org/10.1155/2021/5230882

See, S. F., Ghassem, M., Mamot, S., & Babji, A. S. (2015). Effect of different pretreatments on functional properties of African catfish (*Clarias gariepinus*) skin gelatin. *Journal of Food Science and Technology*, *52*(2), 753–762. https://doi.org/10.1007/s13197-013-1043-6

Soad, H. T., Mehriz, A. M., & Hanafy, M. A. (2014). Quality characteristics of ice milk prepared with combined stabilizers and emulsifiers blends. *International Food Research Journal*, *21*(4), 609–1613. Retrieved March 17, 2023, from http://agris.upm.edu.my:8080/dspace/handle/0/11027

Swastawati, F., Ardie, B. R., Romadhon, Fahmi, A. S., & Purnamayati, L. (2022). The potential of milkfish (*Chanos chanos*) gelatin as stabilizer in ice cream production [Publisher: IOP Publishing]. *IOP Conference Series: Earth and Environmental Science*, *1033*(1), Article 012062. https://doi.org/10.1088/1755-1315/1033/1/012062

Syed, Q. A., Anwar, S., Shukat, R., & Zahoor, T. (2018). Effects of different ingredients on texture of ice cream. *Journal of Nutritional Health & Food Engineering*, *8*(6), 422–435. https://doi.org/10.15406/jnhfe.2018.08.00305

Syed, Q. A., & Shah, M. S. U. (2016). Impact of stabilizers on ice cream quality characteristics. *MOJ Food Processing & Technology*, *3*(1), 246–252. https://doi.org/10.15406/mojfpt.2016.03.00063

Udo, I. I., Etokakpan, O. U., Ukwo, S. P., & Ukpong, E. O. (2021). Evaluation of the proximate compositions, dietary fibre and resistant starch contents of selected varieties of banana and plantain. *Journal of Advances in Food Science & Technology*, *8*(1), 1–9. Retrieved March 17, 2023, from https://www.ikprress.org/index.php/JAFSAT/article/view/6111

Yangilar, F. (2015). Effects of green banana flour on ice cream's physical, chemical and sensory properties. *Food Technology and Biotechnology*, *53*(3), 315–323. https://doi.org/10.17113/ftb.53.03.15.3851