Available online: journal.ipb.ac.id/index.php/jphpi

PHYSICOCHEMICAL CHARACTERISTICS OF LEMI FLAVOR POWDER OF BLUE SWIMMER CRAB (*Portunus pelagicus*) WITH MALTODEXTRIN ADDITION

Indrati Kusumaningrum[1]*, Rahmania Nur Afiah[1], Brian Gregory Adhihendra[2]
[1]Department of Agricultural Product Technology, Vocational School, Sebelas Maret University
Ir. Sutami street 36 Kentingan, Jebres, Surakarta, Central Java Indonesia 57126
[2]Marketing Study Program, Vocational School, Sebelas Maret University
Ir. Sutami street 36 Kentingan, Jebres, Surakarta, Central Java Indonesia 57126

Submitted: 24 October 2024/Accepted: 15 January 2025
*Correspondence: inkusuma81@staff.uns.ac.id

How to cite (APA Style 7th): Kusumaningrum, I., Afiah, R. N., & Adhihendra, B. G. (2025). Physicochemical characteristics of lemi flavor powder of blue swimmer crab (*Portunus pelagicus*) lemi with maltodextrin addition. *Jurnal Pengolahan Hasil Perikanan Indonesia,* 28(1), 13-23. http://dx.doi.org/10.17844/jphpi.v28i1.59919

Abstract

The blue swimmer crab is one of the most important commodities and has high economic value. High export demand is followed by an increase in the volume of by-products, namely semi-solid substances (lemi). Lemi can be used as a flavor, but the product in the market is not optimal. Fillers such as maltodextrin need to be added to improve the flavor characteristics of the powder. This study aimed to determine the best concentration of maltodextrin on the physicochemical characteristics of crab lemi powder flavor. We used a completely randomized design (CRD) to compare the effects of various maltodextrin concentrations (5%, 10%, and 15%) on the yield, cooking loss, bulk density, and proximate composition of the flavor powder. The best concentration was 10% maltodextrin with a 26.68% yield, 73.54% cooking loss, 0.58 g/mL bulk density, 3.14% moisture content, 11.60% ash, 42.40% protein, 11.69% fat, and 31.18% carbohydrate. The addition of maltodextrin to the flavored blue swimmer crab lemi powder has the potential to transform it into a powdered flavoring suitable for a variety of food types.
Keywords: bulk density, cooking loss, proximate, seasoning, yield

Karakteristik Fisikokimia Flavor Bubuk Lemi Rajungan (*Portunus pelagicus*) dengan Penambahan Maltodekstrin

Abstrak

Rajungan merupakan salah satu komoditas penting dan memiliki nilai ekonomi tinggi. Permintaan ekspor yang tinggi diikuti dengan penambahan volume hasil samping, yaitu zat semi padat (lemi). Lemi dapat dimanfaatkan sebagai *flavor*, namun produk tersebut di pasaran belum optimal. Bahan pengisi misalnya maltodekstrin perlu ditambahkan untuk meningkatkan karakteristik *flavor* bubuk. Penelitian ini bertujuan untuk menentukan konsentrasi maltodekstrin terbaik terhadap karakteristik fisikokimia flavor bubuk lemi rajungan. Rancangan acak lengkap (RAL) digunakan untuk membandingkan pengaruh berbagai konsentrasi maltodekstrin (5%, 10%, dan 15%) terhadap rendemen, susut masak, *bulk density*, dan komposisi proksimat bubuk *flavor*. Konsentrasi terbaik, yaitu 10% maltodekstrin, rendemen 26,68%, susut masak 73,54%, *bulk density* 0,58 g/mL, kadar air 3,14%, abu 11,60%, protein 42,40%, lemak 11,69%, dan karbohidrat 31,18%. *Flavor* bubuk lemi rajungan dengan penambahan maltodekstrin berpotensi dikembangkan menjadi penyedap rasa bubuk dan diaplikasikan pada berbagai jenis pangan.
Kata kunci: *bulk density*, penyedap rasa, proksimat, rendemen, susut masak

http://dx.doi.org/10.17844/jphpi.v28i1.59919

INTRODUCTION

The blue swimmer crab (*Portunus pelagicus*) is a species of the phylum Crustacea, family Portunidae, and genus Portunus (Lai *et al.*, 2010). The crab this type is known by the common name blue swimmer crab. It is a crustacean that lives in beach and coastal habitats with bottom substrates of sand, mud sand, and seagrass habitats, to a depth of at least 50 m (Hamid *et al.*, 2016). The blue swimmer crab holds a significant economic value as one of the coastal resources (Iksanti *et al.*, 2022). This is due to the high demand for crab exports every year. The export value of crab reached USD 448 million in 2023. The crab commodity socially provides livelihoods for around 90,000 crab fishermen and 180,000 peelers who process crab (Kementerian Kelautan dan Perikanan [KKP], 2024). The export value of Indonesian fishery products until September 2024 reached USD 4.23 billion with a total export volume of 1.02 million tons (KKP, 2024). A 40.4% increase in king crab exports contributed positively to the growth of Indonesia's overall export value of fishery products.

Each year, a large volume of waste or by-products follows the increasing production and demand for crab (Mursida *et al.*, 2018). This is because crab processing generally only utilizes the meat for various products, namely fresh crab, frozen meat, and processed crab meat in cans (Natalia *et al.*, 2021). Shell waste reaches 40–60% of the total weight of crabs (Rochima, 2014). (Rochima, 2014). The proportion of crab body parts after stripping is 52.59% shell, 35.68% meat, and 11.73% offal (Suwandi *et al.*, 2019). Currently, the utilization of waste and by-products is not optimal, leading to their discarding. This leads to new environmental issues such as pollution, discomfort due to unpleasant odors, and potential disease (Supratman & Umroh, 2016) (Supratman & Umroh, 2016). Amalia *et al.* (2021) have conducted research to map crab waste in Indonesia and process it into chitosan products due to their high added value.

In addition to serving as chitosan, the by-products of crab processing also contain semi-solid substances that remain after processin. The crab shell contains a yellowish material known as lemi. Lemi is a yellowish material found under the surface of the crab shell. When collecting crab meat, it's important to remove Lemi as it can alter the color of the meat if mixed (Azmy *et al.*, 2021). Foods such as rengginang (Badriyah & Jumiati, 2022), shrimp crackers (Jumiati & Suprapti, 2022), and flavors (Sasongko *et al.*, 2018; Nur Fajri *et al.*, 2021; Novitasari *et al.*, 2021) have incorporated lemi. Lemi has challenges when added to food, namely high moisture content, susceptibility to spoilage, and limited shelf life.

The unique flavor of lemi presents a promising opportunity for use as a powdered seasoning. Pandega Food has produced and marketed lemi powder to the community. Most buyers apply lemi powder to food, specifically as an ingredient for shrimp paste. Powdered products have several advantages, including increasing stability, simplifying handling, and expanding usability for various food applications (Wijayanti & Dewi, 2020). Partners still produce lemi powder using simple processing techniques such as drying, roasting, and grinding. Making lemi powder on a business scale is still a challenge because the characteristics produced are not optimal. We need to add filling materials to lemi powder to improve its characteristics effectively and efficiently, considering its economic value. Maltodextrin is a common addition to powdered products.

Commonly used as a carrier agent in powdered products, maltodextrin plays a crucial role in maintaining and protecting flavor compounds during processin (Atungulu & Pan, 2014). In powder drying, maltodextrin serves as a filler and dressing material, protecting important compounds from damage and enhancing yield (Novitasari *et al.*, 2021). Amini *et al.* (2023) research demonstrates that adding maltodextrin to flavor powder can act as a dressing material, shielding the material's compounds from damage. The use of appropriate methods and formulations can improve the flavor characteristics of powders. This study employs a processing method approach that involves steaming, blending, and drying lemi paste with varying levels of maltodextrin, with the aim of enhancing the powder's flavor characteristics and boosting its competitiveness in the market. Before drying, the steaming process inactivates enzymes and eliminates microbial contaminants, and the addition of maltodextrin enhances the stability, dispersibility, and overall quality of the powdered flavor (Agustina *et al.*, 2019; Jaya *et al.*, 2006). Previous studies have shown that maltodextrin concentration affects product characteristics, such as moisture retention, aroma retention, and slurry density. However, there is limited information on how different maltodextrin concentrations affect the flavor of lemi-based powder. Research on the effect of modified processing techniques for crab lemi and maltodextrin incorporation on powder flavor characteristics is limited. This study aimed to determine the best concentration of maltodextrin on the physicochemical characteristics of lemi blue swimmer crab powder flavor.

MATERIALS AND METHODS

Preparation of Flavor Powder from Crab By-products

The main ingredient of the flavor for each treatments is 500 g lemi obtained from crab processing in Rembang, Central Java. Other ingredients used in this study included 5 g salt, as well as variations in maltodextrin concentration percentage according to the lemi (5% = 25 g, 10% = 50 g, and 15% = 75 g). These different concentrations of maltodextrin were used in the formulation of crab lemi to determine their effect on the physicochemical properties of the resulting lemi powder flavor. The procedure for producing lemi rajungan powder flavor is referenced from Wijayanti & Dewi (2020).

The powdered flavor production begins with fresh lemi that is cleaned of impurities. Next, the steaming process lasts for 10 minutes starting from the moment the water boils. The steaming process serves to reduce the risk of spoilage from microorganisms and increase the flavor present in the crab lemi. The experimental design added maltodextrin and salt to the steamed lemi at a predetermined weight percentage. The prepared ingredients were then mixed until homogeneous using a food processor, resulting in a smooth lemi paste. The paste was then poured evenly onto a tray and dried in an oven at 65-70°C until dry. The dried lemi was then ground to a fine powder using a grinder. The ground lemi powder was then sieved using a 60-mesh sieve. Flavored crab lemi powder is then packaged in bottles and capped to maintain its quality, and stored in cool and dry conditions until the product will be analyzed further. Figure 1 presents the flavor of lemi powder.

Physical Test

The physical properties of powdered flavor from crab by-products (lemi) included yield, cooking loss, and bulk density. The yield was calculated as a percentage of the total mass of the resulting lemi flavor powder compared to the total mass of the raw materials before drying. Cooking loss was determined by measuring the weight loss of crab lemi

(A) (B) (C) (D)

Figure 1 Lemi powder flavor; (A) commercial products, (B) with 5% maltodextrin, (C) with 10% maltodextrin, (D) with 15% maltodextrin

Gambar 1 *Flavor* lemi bubuk; (A) produk mitra, (B) 5% maltodekstrin, (C) 10% maltodekstrin, (D) 15% maltodekstrin

http://dx.doi.org/10.17844/jphpi.v28i1.59919

powder during processing (Prabawa *et al.*, 2021; Wijayanti & Dewi, 2020). Bulk density is the ratio of the weight of the material to the volume it occupies, including the empty space between the grains. Bulk density was calculated as the weight of the sample per unit volume of the sample (Kaur & Singh, 2007).

Proximate Analysis

Proximate analysis included moisture, protein, ash, fat, and carbohydrate content. Moisture content was determined using the thermogravimetric method, while protein content was analyzed using the Kjeldahl method. Ash content was measured by combustion in a muffle furnace, and fat content was determined using the Soxhlet extraction method. Carbohydrate content was calculated by the by-difference method. Proximate analysis refers to the AOAC (2005) method.

Data Analysis

The research design used a completely randomized design (CRD) consisting of three treatments of maltodextrin concentration (5, 10, and 15%). The data obtained were statistically analyzed using analysis of variance (ANOVA) to assess statistical significance ($p<0.05$) among treatments. ANOVA results that showed a significant difference were followed by Duncan's Multiple Range Test (DMRT) to determine which treatments were significantly different.

RESULTS AND DISCUSSION

Physical Characteristics

Yield, cooking loss, and bulk density are important physical parameters in a processing process. The addition of maltodextrin at a concentration of 10 and 15% resulted in an increase in yield and a decrease in cooking loss (Table 1). This indicates high process efficiency and product stability (Marques *et al.*, 2014). The addition of maltodextrin with a concentration of 15% increased the bulk density of lemi powder flavor. The percentage yield indicates the efficiency of the process. Higher yields indicate better retention, which is desirable regarding economic and nutritional factors (Patriani *et al.*, 2020).

The functional properties of maltodextrin are responsible for the increase in yield value in this study and the decrease in cooking loss at higher maltodextrin concentrations. The lemi powder flavor yield ranged from 24.68% to 27.44%, while the cooking loss value varied from 72.56% to 75.32%. ANOVA results showed $p<0.05$, indicating significant differences in yield and cooking loss. Significant differences were found in the 15% and 5% treatments ($p<0.05$). ANOVA results with a value of $p<0.05$, showed significant differences in cooking loss parameters. Maltodextrin concentration of 5% had the highest cooking loss (75.32%), while the 15% concentration treatment had the lowest (72.56%). Maltodextrin concentration directly influences the crab lemi powder flavor yield and cooking loss. The results observed in this study are in line with the results reported by Crehan *et al.* (2000), who examined the effect of various concentrations of maltodextrin on the yield obtained. The results showed that increasing the addition of maltodextrin resulted in higher yields and lower cooking loss.

Cooking loss values indicate the amount of weight lost during processing, mainly due to loss of moisture and fat content.

Table 1 Physical characteristic of blue swimmer crab lemi powder flavor
Tabel 1 Karakteristik fisik flavor bubuk lemi rajungan

Maltodextrin (%)	Yield (%)	Cooking loss (%)	Bulk density (g/mL)
5	24.68±1.19[a]	75.32±1.19[a]	0.53±0.03[a]
10	26.46±0.63[b]	73.54±0.63[b]	0.58±0.02[b]
15	27.44±0.66[b]	72.56±0.66[b]	0.62±0.02[b]
Commercial products	30.83±3.82	69.17±3.82	3.44±0.29

Different letters on the same column indicate significant differences ($p<0.05$)

Lower cooking loss values indicate better nutrient and flavor retention (Alpaugh *et al.*, 2020). The decrease in cooking loss values with the addition of higher levels of maltodextrin indicates improved thermal stability and reduced water and fat content during the drying process. These factors may affect the quality, shelf life, and solubility of crab lemi powder flavor. The combination of steaming and oven drying, along with the use of maltodextrin, enhanced the physicochemical properties and quality of the powdered flavor (Luo *et al.*, 2020; McDermott *et al.*, 2018).

The ability of maltodextrin to retain water and minimize weight loss during processing is critical to maintaining the physicochemical characteristics of powdered products. By increasing water binding capacity and reducing weight loss, maltodextrin can contribute to improved product stability, longer shelf life, and better retention of flavor and nutritional components (Ningsih *et al.*, 2019).

The increase in yield and reduction in cooking loss with higher maltodextrin addition showed that the addition of maltodextrin improved the processing characteristics of lemi powder flavor. The water-binding and stabilizing properties of maltodextrin, which can aid in water-binding ability and minimize nutrient loss during processing, are responsible for the high yield and reduction in cooking loss (Ningsih *et al.*, 2019; Ozcelik & Kulozik, 2023). Other research has found that adding maltodextrin (5–20%) to different types of food products, like meat and seafood-based ones, can improve their processing and functional properties (Bebartta *et al.*, 2023; Murphy *et al.*, 2003). These results support what this study found.

Bulk density represents an object's mass in unit volume, accounting for the voids present within the solid. Based on the test results, 15% maltodextrin has a greater bulk density than 5%. This is because a higher concentration of maltodextrin in the powdered crabmeat flavor leads to a higher concentration of soluble solids. As the water content decreases, the particle size of the powdered crab lemi flavor becomes smaller. So that the water content is lower, it makes the particle size of the powdered crab lemi flavor smaller. This is in accordance with the research of Srihari *et al.* (2015), which showed that the higher the concentration of maltodextrin added to garlic powder, the greater the bulk density.

The physical characteristics of lemi flavor products from partners differ from the lemi flavor powder found in research results when maltodextrin was added. The physical characteristics of the partner product were yield 30.83±3.82, cooking loss 69.17±3.82, and bulk density 3.44±0.29. The yield of the partner product was much higher, and the cooking loss was lower due to the different processing process and ingredient composition. The difference led to a significant increase in the product's water content, which in turn increased its weight yield. The difference in the processing process, namely temperature and heating time, is one of the factors that affects the water content, which affects the yield and cooking loss (Buckle *et al.*, 2010). Bulk density can be calculated from the ratio of the weight of the material to the volume it occupies, including the empty space between the grains of material. The bulk density of the partner's product was higher than that of the researched lemi powder flavor. This is influenced by the manufacturing process, such as the sieving process, the size and type of raw materials, and the moisture content of the material or product. Material size and moisture content are factors that affect the physical properties of materials, namely bulk density (Andriani *et al.*, 2013).

Proximate Composition

Proximate analysis was conducted on the raw materials of crab lemi, partner products, and lemi powder flavor products with different maltodextrin variations. The proximate analysis showed significant differences in the content of the lemi powder flavor formulated with various concentrations of maltodextrin. The difference in proximate composition shows the effect of maltodextrin addition on lemi powder flavor characteristics. Table 2 presents the proximate composition data.

http://dx.doi.org/10.17844/jphpi.v28i1.59919

Table 2 Proximate composition of lemi and lemi flavor powder
Tabel 2 Komposisi proksimat bahan baku lemi dan bubuk flavor lemi rajungan

Parameters (%)	Lemi	Commercial products	Maltodextrin (%)		
			5	10	15
Moisture	78.26	14.85±1.09	5.02±0.83[a]	3.14±0.80[b]	3.76±1.03[ab]
Ash	2.40	22.80±1.15	13.47±0.14[a]	11.60±0.18[b]	10.52±0.18[c]
Protein	14.40	43.41±0.61	46.67±0.57[a]	42.40±1.37[b]	36.54±0.60[c]
Fat	0.02	5.16±0.64	13.13±0.51[a]	11.69±0.71[b]	9.48±0.22[c]
Carbohydrate	4.95	13.78±2.38	21.70±1.44[a]	31.18±1.83[b]	39.70±0.85[c]

Different letters on the same row indicate significant differences ($p<0.05$)

Moisture

Moisture content ranged from 3.76% to 5.02%, indicating a difference in moisture content with increasing concentration of maltodextrin used. The water content of fresh lemi and partner products without maltodextrin was higher. Maltodextrin, with its hydrophilic properties and free hydroxyl groups, influences this by binding water more easily to the product (Ratna *et al.*, 2021). ANOVA results showed significant differences ($p<0.05$) in moisture content between treatments. The study's moisture content is lower than that of Wijayanti & Dewi's (2020) research, which found that the powdered flavor's moisture content ranged from 10.83-12.43% when using a combination of fillers, specifically 15% nanocalcium and maltodextrin. This indicates that the formulation in this study is more effective at controlling moisture content, which can lead to an increase in shelf life and product stability.

This study's moisture content matches powder flavors made from crab by-products, which Yusuf *et al.* (2022) process by adding fillers (maltodextrin and gum arabic). The results showed that the moisture content ranged from 2.24% to 3.28%. This highlights the significance of filler selection in enhancing binding ability, a crucial factor in preserving product quality and shelf life.

Maltodextrin affects the moisture content value based on the concentration and type of filler used. Ingredient formulation greatly influences the characteristics and stability of the final product. This can aid in the formulation of powdered flavors and offer insights into how different ingredients can enhance physicochemical characteristics, guarantee product safety, and extend shelf life (Mauer *et al.*, 2019). Li *et al.* (2020)and the dynamic release of flavor substances during dissolution. MDs with three different DE values and whey protein isolate were mixed in a ratio of 4:1 as wall materials to encapsulate ethyl acetate, and powdered microcapsules were prepared by spray drying. It was proved that MD could reduce the diffusion of flavor substances under different relative humidity conditions through the interaction between core material and wall material. During dissolution, MD released flavor substances quickly owing to its superior solubility. The reconstituted emulsion formed after the powder dissolved in water recaptured flavor substances and made the system reach equilibrium. This study explored the mechanism of flavor release during the storage and dissolution of powder micro capsules and should help us understand the application of powder micro-capsules in food systems.(Li et al., 2020 suggest that the selection of ingredient type and concentration, like maltodextrin, can enhance the moisture content, nutrient retention, and overall product quality and stability of powdered flavor products.

Ash

The resulting ash content was 10.52-13.47%, showing a decrease as the maltodextrin content increased. The lack of minerals in lemi raw material results in a low ash content, while the proportion of other ingredients influences the high ash content of the partner product. ANOVA results of ash content showed significant differences ($p<0.05$) between treatments. Duncan's further test results showed a significant difference between all treatments: 5% (13.47%) > 10% (11.60%) > 15% (10.52%). The 5% maltodextrin treatment had the highest ash content at 13.47%, and the 15% maltodextrin treatment had the lowest at 10.52%. Ash content decreased with increasing maltodextrin. The properties of maltodextrin are responsible for the decrease in ash content with higher maltodextrin addition. Maltodextrin is a filler made of carbohydrates and almost no minerals. When added in large amounts, it lowered the concentration of minerals that came from crab waste.

Increasing maltodextrin reduces the amount of other components, including the mineral content of an ingredient, leading to a decrease in ash content (Atma & Pakpahan, 2020; Manikandan *et al*., 2020). The lower ash content in crab lemi powder flavor with more maltodextrin is likely due to the carbohydrate-rich maltodextrin dissolving the mineral components of the product. Ash content is the mineral content of a product, indicating the presence of important minerals such as calcium, phosphorus, and iron from the crab lemi powder flavor. Minerals present in powdered flavors are also essential nutrients that can contribute to various physiological processes and functions important for human health (Aubourg *et al*., 2021; Lee *et al*., 2022).

Protein

The protein content of lemi powder flavor was 36.54-46.67%, with statistically significant differences (p<0.05) between treatments. The 5% maltodextrin concentration had the highest protein content (46.67%), while the 15% maltodextrin concentration had the lowest protein content (36.54%). The protein content of fresh lemi raw materials is lower than that of partner products and lemi powder flavor when maltodextrin is added. The addition of maltodextrin tends to change the protein content of the final product due to the proportion of proximate results. The dilution effect, which increases maltodextrin concentration, leads to changes in protein content (Gibis *et al*., 2021). The addition of high-carbohydrate maltodextrin lowers the product's protein concentration. The higher proportion of maltodextrin in the 15% treatment effectively reduced the concentration of the product's protein component, resulting in lower protein levels.

The study conducted by Sasongko *et al.* (2018) yielded a protein content of 34-43% from the lemi powder flavor. The concentration and type of crab by-product, along with the processing method, contribute to the variation in protein content. Influencing factors such as cooking time, temperature, and drying method can also play a role in producing high-protein products (Hao *et al*., 2021).

Fat

The fat content of the crab lemi powder flavor varied across the three treatments, ranging from 9.48% to 13.13%. ANOVA results showed statistically significant differences (p<0.05) in fat content among the different maltodextrin concentration treatments. The 5% maltodextrin formulation had the highest fat content, while the 15% maltodextrin formulation had the lowest fat content among the three treatments.

Both the raw material, fresh lemi, and the partner product are low in fat content. The addition of maltodextrin increased the fat proportion of the product, but the higher the maltodextrin concentration, the more the fat changed. Several factors contribute to the change in fat content as the maltodextrin concentration increases. Maltodextrin acts as a barrier around the fat globules and prevents coalescence. This encapsulation not only reduces the overall fat content but also improves the flavor stability of the powder by minimizing lipid oxidation, which can lead to off-flavors and reduced shelf life (Byun *et al*., 2010; English *et al*., 2023). The dilution and encapsulation effects of maltodextrin lead to a reduction in fat content as the concentration of maltodextrin in the formulation increases (Oliver & Alquicira, 2022). Higher amounts of maltodextrin can reduce the proportion of other components, namely fat, in a compound. The fat-binding ability of maltodextrin can help reduce the fat content of the final product (Crehan *et al*., 2000).

http://dx.doi.org/10.17844/jphpi.v28i1.59919

Carbohydrate

The carbohydrate content of crab lemi powder flavor showed a positive correlation with increasing maltodextrin concentration. The carbohydrate properties of maltodextrin itself primarily account for this. Maltodextrin, as a polysaccharide composed of glucose units, contributes significantly to the overall carbohydrate profile of the final product (Lee *et al*., 2022; Takeiti *et al*., 2010).

Increasing carbohydrate content with higher concentrations of maltodextrin can be advantageous in several ways. Maltodextrin can increase the energy density of powder flavors, making the ingredients more calorie-dense. Increased carbohydrate content, especially from maltodextrin, can also contribute to improved mouthfeel and texture (Murphy *et al*., 2003; Wang & Zhou, 2012). Maltodextrin is known to impart a smooth and creamy texture to food products, which can enhance sensory appeal. An enhanced texture can be desirable in powdered flavor applications, such as adding to sauces, soups, or other processed creations (Wang & Zhou, 2012; McDermott *et al*., 2018; Sasongko *et al*., 2018).

This study showed that maltodextrin concentration affected ash, protein, fat, and carbohydrate content. A maltodextrin level of 10% improved the moisture content and was associated with higher yields, indicating better process efficiency and potentially longer shelf life. Moisture content is inversely proportional to maltodextrin concentration, as maltodextrin helps reduce the moisture content in the final product.

CONCLUSION

The addition of maltodextrin affected the physicochemical characteristics of blue swimmer crab lemi powder's flavor. Maltodextrin 10% was the best concentration to produce blue swimmer crab lemi powder flavor. Maltodextrin 10% was effective and efficient in improving the physicochemical characteristics of crab lemi powder flavor. Lemi rajungan powder flavor has the potential to be developed and applied to various types of food.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the support and funding provided by the Kedai Reka INOVOKASI Program organizers for this research project (contract number 230/UN27.26/HK.07.00/2024). We would also like to thank our industrial partner, Pandega Food, for their collaboration and the information and facilities provided in this activity. Finally, we would like to thank the support from Sebelas Maret University during this research activity.

REFERENCE

Alpaugh, M., Pope, L., Trubek, A., Skelly, J., & Harvey, J. (2020). Cooking as a health behavior: examining the role of cooking classes in a weight loss intervention. *Nutrients*, 12(12), 3669. https://doi.org/10.3390/nu12123669

Amalia, K. P., Ekayani, M., & Nurjanah. (2021). Pemetaan dan alternatif pemanfaatan limbah cangkang rajungan di Indonesia. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 24(3), 310-318.

Amini, K., Susanto, E., & Suharto, S. (2023). Karakteristik fisikokimia flavor bubuk kepala udang vanamei (*Litopenaeus vannamei*) dengan perbedaan konsentrasi maltodekstrin pada metode *foam mat drying*. *Jurnal Ilmu dan Teknologi Perikanan*, 5(2), 99-110.

Andriani, M., Ananditho, P. K., Nurhartadi, E. (2013). Pengaruh suhu pengeringan terhadap karakteristik fisik dan sensoris tepung tempe "bosok". *Jurnal Teknologi Hasil Pertanian*, 6(2), 95-102.

[AOAC] Association of Official Analytical Chemists. (2005). Official Methods of Analysis of AOAC International. 18th edition. Edited by Horwitz, W. & Latimer, Jr. G.W.

Atma, Y., & Pakpahan, J. W. (2020). Effect maltodextrin on hedonic attributes of tray-dried fish gelatin powder from bone of *Pangasius* sp. *Indonesian Food Science & Technology Journal*, 3(1), 13–17. https://doi.org/10.22437/ifstj.v3i1.9542

Atungulu, G. G., & Pan, Z. (2014). Rice industrial processing worldwide and impact on macro- and micronutrient content, stability, and retention. *Annals of the New York Academy of Sciences*, 1324(1), 15–28. https://doi.org/10.1111/nyas.12492

Aubourg, S. P., Trigo, M., Prego, R., Cobelo-García, A., & Medina, I. (2021). Nutritional and healthy value of chemical constituents obtained from patagonian squid (*Doryteuthis gahi*) By-products captured at different seasons. *Foods*, 10(9), 2144. https://doi.org/10.3390/foods10092144

Azmy, S. N., Riyadi, P. H., Swastawati, F., & Suharto, S. (2021). Prediksi potensi biologis komponen kimia hasil samping hidrolisat lemi rajungan menggunakan *pass online*. *PENA Akuatika*, 20(2), 46-59.

Badriyah, L., & Jumiati. (2022). Penambahan lemi rajungan (*Portunus pelagicus*) pada pembuatan rengginang terhadap nilai gizi produk. *Prosiding Seminar Nasional Penelitian dan Pengabdian Masyarakat*, 7(1), 900-903.

Bebartta, R. P., Umar, M., Ruktanonchai, U. R., & Anal, A. K. (2023). Development of cryo-desiccated whey and soy protein conglomerates; effect of maltodextrin on their functionality and digestibility. *Journal of Food Process Engineering*, 46(7). https://doi.org/10.1111/jfpe.14350

Buckle, K.A., Edwards, R.A., Fleet, G.H., & Wootton, M. (2010). *Food Science*. Penerjemah Hari Purnomo dan Adiono dalam Ilmu Pangan. Universitas Indonesia Pres. Jakarta

Byun, Y., Kim, Y. T., Desai, K. G. H., & Park, H. J. (2010). Microencapsulation techniques for food flavour. In *The Chemistry and Biology of Volatiles*, 307–332. https://doi.org/10.1002/9780470669532.ch12

Calderón-Oliver, M., & Ponce-Alquicira, E. (2022). The role of microencapsulation in food application. *Molecules*, 27(5), 1499. https://doi.org/10.3390/molecules27051499

Crehan, C. M, Hughes, E., Troy, D. J., & Buckley, D. J. (2000). Effects of fat level and maltodextrin on the functional properties of frankfurters formulated with 5, 12 and 30% fat. *Meat Science*, 55(4), 463–469. https://doi.org/10.1016/S0309-1740(00)00006-1

English, M., Okagu, O. D., Stephens, K., Goertzen, A., & Udenigwe, C. C. (2023). Flavour encapsulation: A comparative analysis of relevant techniques, physiochemical characterisation, stability, and food applications. *Frontiers in Nutrition*, 10. https://doi.org/10.3389/fnut.2023.1019211

Gibis, M., Pribek, F., Kutzli, I., & Weiss, J. (2021). Influence of the protein content on fiber morphology and heat treatment of electrospun potato protein–maltodextrin fibers. *Applied Sciences*, 11(17), 7896. https://doi.org/10.3390/app11177896

Hamid, A., Wardiatno, Y., Tumpal, D., Lumbanbatu, F., & Riani, E. (2016). Stock status and fisheries exploitation of blue swimming crab *Portunus pelagicus* (Linnaeus 1758) in Lasongko Bay, Central Buton, Indonesia. *Asian Fish Science*, 29, 206–219. https://doi.org/10.33997/j.afs.2016.29.4.004

Hao, G., Hu, Y., Shi, L., Chen, J., Cui, A., Weng, W., & Osako, K. (2021). Physicochemical characteristics of chitosan from swimming crab (*Portunus trituberculatus*) shells prepared by subcritical water pretreatment. *Scientific Reports*, 11(1), 1646. https://doi.org/10.1038/s41598-021-81318-0

Iksanti, R. M., Redjeki, S., Taufiq-Spj, N. (2022). Aspek biologi rajungan (P*ortunus pelagicus*) Linnaeus, 1758 (Malacostraca : Portunidae) ditinjau dari morfometri dan tingkat kematangan gonad di TPI Bulu, Jepara. *Journal of Marine Research*, 11(3), 495-505.

Jumiati, & Suprapti, Y. (2022). Nilai nutrisi kerupuk udang dengan penambahan lemi rajungan (*Portunus pelagicus*). *Prosiding Seminar Nasional Penelitian dan Pengabdian Masyarakat*, 7(1), 358-362.

Kaur, M., & Singh, N. (2007). Relationships between various functional, thermal and pasting properties of flours from different Indian black gram (*Phaseolus mungo* L.) cultivars. *Journal of the Science of Food* *and Agriculture,* 87(6), 974–984. https://doi.org/10.1002/jsfa.2789

[KKP] Kementerian Kelautan dan Perikanan. 2024. Siaran Pers Kementerian Kelautan dan Perikanan Nomor: SP.077/SJ.5/III/2024. Jakarta: Kementerian Kelautan dan Perikanan.

[KKP] Kementerian Kelautan dan Perikanan. 2024. Siaran Pers Kementerian Kelautan dan Perikanan Nomor: SP.386/SJ.5/X/2024. Jakarta: Kementerian Kelautan dan Perikanan.

Lai, J. C. Y., Ng, P. K. L., & Davie, P. J. F. (2010). A revision of the *Portunus pelagicus* (Linnaeus, 1758) species complex (Crustacea: Brachyura: Portunidae), with the recognition of four species. *The Raffles Bulletin of Zoology*, 58(2), 199–237.

Lee, G. Y., Jung, M. J., Nam, J. W., Han, A. R., Kim, B. M., & Jun, J. Y. (2022). Preparation and taste profiling of the enzymatic protein hydrolysate from a by-product of red snow crab processing as a natural seasoning compound. *Foods*, 11(23), 3911. https://doi.org/10.3390/foods11233911

Li, K., Pan, B., Ma, L., Miao, S., & Ji, J. (2020). Effect of dextrose equivalent on maltodextrin/whey protein spray-dried powder microcapsules and dynamic release of loaded flavor during storage and powder rehydration. *Foods*, 9(12), 1878. https://doi.org/10.3390/foods9121878

Luo, H., Li, C., Zhou, T., Kong, X., Chen, Y., Jiang, L., & Yu, L. (2020). Effect of antibacterial treatments and natural chemicals on the quality and safety of marinated raw crab paste during storage at −20°C. *Journal of Food Safety*, 40(4). https://doi.org/10.1111/jfs.12808

Manikandan, V., Sravani, K., Dhanapal, K., Reddy, D., Kumar, G. P., & Deepika, B. (2020). Proximate composition and organoleptic evaluation of extruded snacks enriched with shrimp processing by-product. *Journal of Entomology and Zoology Studies*, 8(6), 1989–1992. https://doi.org/10.22271/j.ento.2020.v8.i6aa.8114

Marques, G. R., Borges, S. V., de Mendonça, K. S., de Barros Fernandes, R. V., & Menezes, E. G. T. (2014). Application of maltodextrin in green corn extract powder production. *Powder Technology*, 263, 89–95. https://doi.org/10.1016/j.powtec.2014.05.001

Mauer, L. J., Forny, L., Meunier, V. D. M., & Taylor, L. S. (2019). Optimizing the quality of food powder products: the challenges of moisture-mediated phase transformations. *Annual Review of Food Science and Technology*, 10(1), 457–478. https://doi.org/10.1146/annurev-food-032818-121224

McDermott, A., Whyte, P., Brunton, N., Lyng, J., & Bolton, D. J. (2018). Increasing the yield of irish brown crab (*Cancer pagurus*) during processing without adversely affecting shelf-life. *Foods*, 7(7), 99. https://doi.org/10.3390/foods7070099

Murphy, M. G., Skonberg, D. I., Camire, M. E., Dougherty, M. P., Bayer, R. C., & Briggs, J. L. (2003). Chemical composition and physical properties of extruded snacks containing crab-processing by-product. *Journal of the Science of Food and Agriculture*, 83(11), 1163–1167. https://doi.org/10.1002/jsfa.1520

Mursida, Tasir, Sahriawati. (2018). Efektifitas larutan alkali pada proses deasetilasi dari berbagai bahan baku kitosan. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 21(2), 356-366

Natalia, D. A., Dharmayanti, N., & Dewi, F. R. (2021). Produksi kitosan dari cangkang rajungan (*Portunus* sp.) pada suhu ruang. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 24(3), 301-309.

Ningsih, R., Sudarno, & Agustono. (2019). The effect of maltodextrin concentration on the characteristics of snappers' (*Lutjanus* sp.) peptone. *IOP Conference Series: Earth and Environmental Science*, 236, 012127. https://doi.org/10.1088/1755-1315/236/1/012127

Nur Fajri, F. A., Sumardianto, S., & Rianingsih, L. (2021). Penambahan anti kempal magnesium karbonat ($MgCO_3$) terhadap karakteristik flavor lemi rajungan

(*Portunus pelagicus*). *Jurnal Ilmu dan Teknologi Perikanan*, 3(2), 113-122.

Novitasari, R. T. M., Anggo, A. D., & Agustini, T. W. (2021). Pengaruh kombinasi bahan pengisi maltodekstrin dan karagenan terhadap karakteristik bubuk flavor lemi dari rajungan. *Jurnal Ilmu dan Teknologi Perikanan*, 3(1), 16-25.

Ozcelik, M., & Kulozik, U. (2023). The role of maltodextrin concentration in maintaining storage stability of dried fruit foams texturized using plant protein–polysaccharide blends. *Foods*, 12(8), 1673. https://doi.org/10.3390/foods12081673

Patriani, P., Hafid, H., Mirwandhono, E., Wahyuni, T. H., Hasanah, U., Apsari, N. L., & Ginting, N. (2020). Physical quality characteristics of lamb meat using Pangium edule extract at different storage times. *IOP Conference Series: Earth and Environmental Science*, 454(1), 012056. https://doi.org/10.1088/1755-1315/454/1/012056

Prabawa, S., Putri, D. K. R., Kawiji, K., & Yudhistira, B. (2021). Pengaruh variasi waktu ozonisasi dan suhu penyimpanan terhadap karakteristik fisika, kimia, dan sensoris pada daging ayam broiler (*Gallus domesticus*). *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, 9(2), 168–184. https://doi.org/10.29303/jrpb.v9i2.277

Ratna, N. K. A. N., Puspawati, G. A. D., & Permana, I. D. G. M. (2021). Pengaruh konsentrasi maltodekstrin dan tween 80 terhadap karakteristik bubuk minuman instan bunga gumitir (*Tagetes erecta* L.). *Jurnal Ilmu dan Teknologi Pangan*, 10(4), 761-777. https://doi.org/10.24843/itepa.2021.v10.i04.p21.

Rochima, E. (2014). Kajian pemanfaatan limbah cangkang rajungan dan aplikasinya untuk bahan minuman kesehatan berbasis kitosan. *Jurnal Akuatika*, 5(1), 71-82.

Sasongko, A. Y., Dewi, E. N., & Amalia, U. (2018). The utilization of blue swimming crab (*Portunus pelagicus*) waste product, lemi, as a food flavor. *IOP Conference Series: Earth and Environmental Science*, 102, 012030. https://doi.org/10.1088/1755-1315/102/1/012030

Srihari, E., Lingganingrum, F. S., Damaiyanti, D., & Fanggih, D. (2015). Ekstrak bawang putih bubuk dengan menggunakan proses *spray drying*. *Jurnal Teknik Kimia*, 9(2), 62-68.

Supratman, O., & Umroh. (2016). Pemberdayaan masyarakat dalam pemanfaatan limbah cangkang rajungan sebagai pakan ikan di Desa Tukak, Bangka Selatan. *Jurnal Pengabdian Kepada Masyarakat Universitas Bangka Belitung*, 3(2), 8-14.

Suwandi, R., Nurjanah, & Maharani, S. (2019). Perbedaan waktu penanganan terhadap bobot, komposisi proksimat, dan asam amino rajungan kukus. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 22(1), 128-135.

Takeiti, C. Y., Kieckbusch, T. G., & Collares-Queiroz, F. P. (2010). Morphological and physicochemical characterization of commercial maltodextrins with different degrees of dextrose-equivalent. *International Journal of Food Properties*, 13(2), 411–425. https://doi.org/10.1080/10942910802181024

Wang, W., & Zhou, W. (2012). Characterization of spray-dried soy sauce powders using maltodextrins as carrier. *Journal of Food Engineering*, 109(3), 399–405. https://doi.org/10.1016/j.jfoodeng.2011.11.012

Wijayanti, I., & Dewi, E. N. (2020). The characteristics of nanocalcium flavor powder made from waste stewed water of swimming crab *Portunus pelagicus* L. *IOP Conference Series: Earth and Environmental Science*, 530(1), 012013. https://doi.org/10.1088/1755-1315/530/1/012013

Yusuf, M., Yonata, D., Pranata, B., & Nurhidajah. (2022). Utilization of swimming crab by-product as a seafood flavor microcapsules obtained by spray drying. *AACL Bioflux*, 15(2), 716–724. http://www.bioflux.com.ro/docs/2022.716-724.pdf