International Journal of Advances in Applied Sciences (IJAAS)
Vol. 12, No. 3, September 2023, pp. 226~233
ISSN: 2252-8814, DOI: 10.11591/ijaas.v12.i3.pp226-233

The effect of adding sodium tripolyphosphate on thiobarbituric acid value, crispiness, and organoleptic on salted egg crackers

Siti Susanti, Rafli Zulfa Kamil, Finky Firsya Fardiah
Department of Agriculture, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro, Semarang, Indonesia

Article Info

Article history:

Received Apr 11, 2023
Revised Jul 15, 2023
Accepted Aug 6, 2023

Keywords:

Crackers
Crispiness
Salted egg
Sodium tripolyphosphate

ABSTRACT

Crackers are one of the dry foods that can experience volume expansion when fried. Salted egg crackers are a form of innovation and product diversification in crackers, which are made using ingredients containing starch and various other additives. This study aims to determine the exact concentration in the use of sodium tripolyphosphate as a crunch in dough on the crispness, thiobarbituric acid (TBA) value, and organoleptic of the salted egg crackers. There were 4 sodium tripolyphosphate (STPP) concentration treatments, namely 0% (T1), 0.25% (T2), 0.5% (T3), and 0.75% (T4). This research method consists of experimental design, research procedures, parameter tests, and data analysis. The results of the analysis of the TBA value showed that the difference in the concentration of STPP affected the rancidity of the salted egg crackers, where the higher the concentration of STPP, the higher the TBA value. Crispness and organoleptic analysis showed the highest value and overall preference, namely 0.75% (T3) treatment. This study concludes that the difference in the concentration of the addition of sodium tripolyphosphate affects the crispness of crackers.

Corresponding Author:

Rafli Zulfa Kamil
Department of Food Technology, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro
Prof Soedarto, S.H. Street, Tembalang, Semarang 50275, Indonesia
Email: raflizulfakamil@lecturer.undip.ac.id

1. INTRODUCTION

Crackers are a type of snack that expands in volume during frying. Crackers are included in trade commodities with good sales potential, which can be seen from the high level of public interest in crackers. In addition to the easy manufacturing process, low price, and easy-to-find ingredients, this increases the potential for promising cracker products to be developed. The development of crackers has been carried out with various modifications of other additives to improve the taste such as skin crackers, shrimp crackers, fish crackers, sand crackers, and others. Their crunchy texture makes crackers often consumed as a snack or side dish and can add to the taste and aesthetic value of the main dish [1]. Currently, there have been many cracker developments made with the addition of protein ingredients, such as prawn crackers, fish crackers, and salted egg crackers.

Salted egg crackers are evidence of the development of cracker processing. The salted eggs are used as mixed ingredients with other ingredients such as tapioca flour and seasonings. The mixed dough is then added to hot water gradually until it's smooth. Cracker diversification by making salted egg crackers is also a solution for salted egg traders or producers to extend the shelf life of salted eggs and overcome salted egg crackers that fail to sell. The length of the trade chain in the process of distribution and storage that is not quite right causes eggs to experience a decrease in their shelf life even though they have been preserved by

salting. The shelf life of salted eggs without being given preservation treatment (control) has a shelf life of only 15 days [2].

According to the Indonesian Ministry of Health, from the 2019 Indonesian Food Composition Table (TKPI) data, 100 grams of salted eggs contain 13.6 grams of protein [3]. This shows that the use of salted eggs in large quantities in the cracker mixture allows for an increase in the total solids in the crackers so that the breaking power of the crackers will be higher, or the crackers tend to be hard which can reduce the crispness of the crackers. According to Olgun and Aygun [4], strong peptide bonds in proteins can increase breaking strength because it takes a large amount of energy to break crackers. Meanwhile, a product can be said to be a cracker if it has a light mass and a good crispness, where the crispiness of the crackers determines the quality of the crackers.

This problem can be overcome by adding a food additive in the form of a cruncher in the dough which is expected to help reduce the breaking strength and increase the crispiness of the crackers. The use of crisps can reduce the breaking power of crackers because it can increase the crackers' swelling power. The higher the swelling, the higher the crispiness [5]. The most commonly used crunchy ingredient is baking powder. Unfortunately, baking powder can increase the value of the water content because baking powder is capable of forming CO^2 gas and water [6]. Thus, this study used a preservative in the form of sodium tripolyphosphate (STPP), which has the property of water-holding capacity or the ability to bind water [7]. These properties make it possible to maintain the shelf life, crispness, and rancidity of crackers. STPP is used to bind water so that the water in the dough does not evaporate easily and so that the surface of the dough does not quickly dry and harden. In addition, the use of STPP can add flavor, and texture, prevent rancidity, and improve the quality of the final product by binding to nutrients that dissolve in a salt solution [8]. Thus, it is possible to increase the expansion of the dough during boiling, thus the crackers have a higher swelling power. This research was conducted to get the right concentration for adding sodium tripolyphosphate as a crisp with concentrations of 0%, 0.25%, 0.5%, and 0.75% in salted egg cracker dough, as well as to increase the flavor of salted egg crackers.

2. RESEARCH METHOD

In this research there were two main ingredients used, the first one is ingredients for crackers production and the second one is ingredients for analysis. Experiments were conducted to determine the optimization of the addition of sodium tripolyphosphate as a crunchy ingredient in salted egg cracker dough for rancidity, physical quality, and consumer preferences. The ingredients used for crackers production were tapioca flour (Gunung Agung, Indonesia), salted eggs obtained from the Rasamala market which are produced in Ungaran, Semarang regency, and other spices, food-grade yellow coloring (Koepoe – Koepoe, Indonesia), and cooking oil. Meanwhile, the ingredients for analysis were distilled water, 4 M HCL, and 0.02 M thiobarbituric acid (TBA) reagent.

2.1. The process of making salted egg crackers

First, all the ingredients are weighed according to the measurements in Table 1. The sample uses two salted eggs that have been washed, then sodium tripolyphosphate is added according to each treatment T1 with 0%, T2 with 0.25%, T3 with 0.5%, and T4. with 0.75%. The dough preparation begins by mixing 260 grams of tapioca flour with salt, garlic powder, pepper powder, and mushroom bouillion, then mix well. Add 2 salted eggs that have been boiled or steamed, halve them, then scoop them from their shells and add to the mixture. All the ingredients are stirred while smoothing the salted eggs in the dough. The dough was mixed evenly, then divided into two with the formula 70% white dough and 30% yellow dough which was dripped with 1 ml of yellow dye. The flour mixture that has been mixed evenly is mixed with hot water slowly little by little until it becomes lumpy. The smooth white dough is rolled out flat with a roller pin, while the yellow dough is shaped into elongated ovals. The yellow dough is rolled with the white dough and then wrapped in aluminum foil. The dough is boiled for 30 minutes. After the dough is cooked, let it rest in the refrigerator for 24 hours. After it cools and hardens, cut it thinly and dried in the sun to dry about 2 or 3 days [9]. Crackers that have been dried, then fried in hot oil.

Table 1. Use of raw materials of salted egg cracker sample

Ingredient	Sample Code (%)			
	0	0.25	0.5	0.75
Salted egg	2	2	2	2
Tapioca flour	260	260	260	260
Salt (gr)	2	2	2	2
Garlic powder(gr)	4	4	4	4
Mushroom seasoning powder (gr)	4	4	4	4
Pepper powder (gr)	1	1	1	1
Sodium Tripolifosfat (%)	0	0.25	0.5	0.75

2.2. TBA value

The TBA value test refers to [10] with modifications. Salted egg crackers as much as 5 grams and added 50 ml of distilled water and 5 ml of 4M HCL in Erlenmeyer and shaken until homogeneous. Once homogeneous, then filtered using filtrate paper. The sample filtrate was taken and distilled until the sample volume reached 50 ml, take 10 ml of the sample that had been distilled, then 5 ml of TBA reagent and heated for 45 minutes. After heating, the sample was cooled down for 10 minutes and diluted to 10 ml with aquadest. After that homogenized using a vortex, and then read with an absorption spectrophotometer at a wavelength of 528 nm. The results obtained are recorded and calculated. The TBA number is defined as mg of malonaldehyde per kg of sample. The result of the analysis of TBA Values is calculated using (1).

$$\text{TBA number} = \frac{sample\ absorbance \times dilution\ factor \times 7.8}{sample\ weight} \quad (1)$$

2.3. Physical analysis

The crispness test used the Lloyd Instruments texture analyzer puncture method [11]. Testing was carried out with a probe (spherical with a diameter of 0.5 cm) and Nexygen software on a personal computer (PC) linked to the texture analyzer. Calibrate texture analyzer form software to clear it of all products. Place the sample onto the plate that has been installed. Fill in the file ID and file number and make sure where the data file will be saved on Nexygen software. Click 'start' and the machine will start the measurement. The graphs will be formed on the monitor as well as numerical data.

2.4. Sensory analysis

Organoleptic testing was carried out using 25 trained panelists. In this test, panelists were asked to give personal assessments of sensory characteristics which included color, taste, aroma, and product overall. Rating is written in numbers 1-5. The color assessment was seen based on the color from brown "1" to white "5", in the taste assessment it was assessed from very not tasty "1" to very tasty "5", in the aroma assessment it was assessed from a very rancid smell "1" to very does not smell rancid "5", and in the overall assessment the panelists judge based on the preferences of the four previous characteristics, namely liking "1" to very liking "5".

2.5. Statistic analysis

Data analysis was performed using data obtained from the analysis of TBA values and crispiness was analyzed by analysis of variance (ANOVA) with a significance level ($p<0.05$) to determine the effect of the treatment. If there is a significant treatment effect, proceed with the Duncan Multiple Range Test to determine the differences between the treatments given. In addition, the data obtained from the organoleptic test was tested by the Kruskal-Wallis test. Data analysis was performed using SPSS 26.0 software.

3. RESULTS AND DISCUSSION

3.1. Analysis of salted egg crackers TBA value

The results show the rancid value of crackers which can be seen in Figure 1. Based on Figure 1, it can be seen that variations in the concentration of sodium tripolyphosphate in the dough for salted egg crackers have a significant effect on the TBA value. The TBA values obtained from salted egg crackers with the addition of sodium tripolyphosphate ranged from 3.8–12.2 mg.mal/kg which was obtained by the ANOVA test followed by the Duncan test. The lowest rancidity was in the 0% treatment, namely 3.8 mg.mal/kg and the highest rancidity was in the 0.75% treatment. So, it can be concluded that the more STPP added, the more rancidity of salted egg crackers will increase. The use of STPP can maintain fat in salted egg crackers. This is a factor for rancidity to occur more quickly. The fat in salted egg crackers also comes from the frying process with oil. The heating process causes the STPP polymer chains to shorten so

that the reactivity of the STPP chains becomes stronger to bind water and fat [12]. This is also related to the decrease in crispness when using STPP above 0.5%. Shorter STPP polymer chains are stronger to bind water during storage, making it easier for crackers to become moist or soggy.

The rancidity of the crackers is also caused by the frying factor and the long storage time. Frying crackers with oil can affect the fat content of the crackers. Fat content can cause rancidity reactions and change the taste and aroma of the product so that it can affect shelf life [13]. Reduction of fat content after frying can be reduced by using a spinner in draining, unfortunately, this was not done in this study. During storage, oxidation reactions can occur in crackers if oxygen is present in the packaging [14].

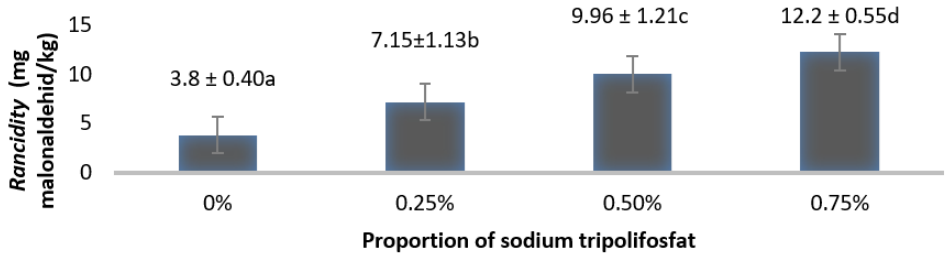

Figure 1. TBA value of crackers with the addition of STPP. Data are shown as Mean ± Standard Deviation, in which different superscripts on the bar indicate significant differences between treatments ($p<0.05$).

3.2. Crispness test result

Crispness is a condition where the volume of space in the material filled with water evaporates during frying, then the space is filled with air so that the volume of the final space is greater than the volume of the initial space after being drained from the frying oil. Crispness is the main quality characteristic of cracker products [15]. The crispiness is also influenced by the density of the crackers, where the density of the crackers will affect the density of the material. The denser the ingredients in the crackers, the harder the crackers. The low cracker density is supported by the amylopectin component in the cracker dough starch which will also increase its swelling power [16].

The average value of crispness of crackers can be seen in Figure 2 where the crispness value increases up to 0.5% treatment. The results showed that the crispiness of salted egg crackers added with STPP to the dough ranged from 1652.11–1730.14 gf. The smallest crispiness value in the 0% treatment was 1403.26 gf. The crispiness of salted egg crackers had the highest crispiness in the treatment with the addition of 0.5% STPP, namely 1730.14 gf, then there was a decrease in crunchiness in the treatment with the addition of 0.75% STPP, namely 1615.39 gf. The addition of STPP to the cracker dough affects the level of product crispiness.

Sodium tripolyphosphate can thicken cracker dough and provide good physical properties to crackers. The use of STPP with a concentration of 0.5% gives the highest crispiness. In a previous study [17], the use of STPP instead of cans could provide good physical characteristics to the volume of cracker expansion. STPP can affect the volume of dough expansion because of the bond between starch and phosphate diester which can strengthen and stabilize the dough. The use of STPP in cracker dough forms a cross-linking modification, namely cross-linking by replacing the -OH group with another functional group. In this case, there is a replacement of the group with a phosphate group from STPP. Sodium tripolyphosphate is a material that can function as a cross-linking agent by changing the starch structure to make it stronger and as a reagent that strengthens the bond between amylose and amylopectin [18]. This cross-linking can increase the strength of starch granules which prevents damage to the gelatinization process [19]. Thus, the use of STPP with the right concentration can affect the swelling volume of the dough which affects the swelling and crispness of the crackers when fried. The more used STPP in crackers, it tends to reduce the water content and increase the swelling volume, so that the crackers become crunchier [20]. In addition, the function of STPP can increase the water-holding capacity of proteins. The greater the concentration of STPP added, the greater the water-holding capacity (WHC) in the product [21]. Phosphate compounds in STPP can increase the water-holding capacity of the product. Phosphate compounds in food function to increase the capacity of water entrapment, so they can maintain moisture [22].

The decrease in crispness in the product with 0.75% treatment can be caused by the excessive concentration of STPP in the dough which can limit the reduction in swelling power when the dough is cooked. The decrease in swelling power due to too much STPP concentration reduces the ability to bind

water because there are more phosphate binders by amylose or amylopectin molecules which cause swelling to be limited [23]. Limited swelling causes the dough's swelling to decrease and reduces the crunchiness of the salted egg crackers after frying. Other factors that reduce crispiness are packaging and storage time. Storage time is also a factor as more water content is stored and bound in the crackers which causes a decrease in the crispiness of the crackers. The thickness of the low-density polyethylene (LDPE) plastic packaging material is easily penetrated by moisture with changes in temperature and storage time [24]. In the 0.75% STPP treatment, it tends to absorb moisture more easily during storage. This is due to the shortening of the STPP polymer chains during frying which increases the rancidity and water content because the polymer chains become stronger in binding fat and water.

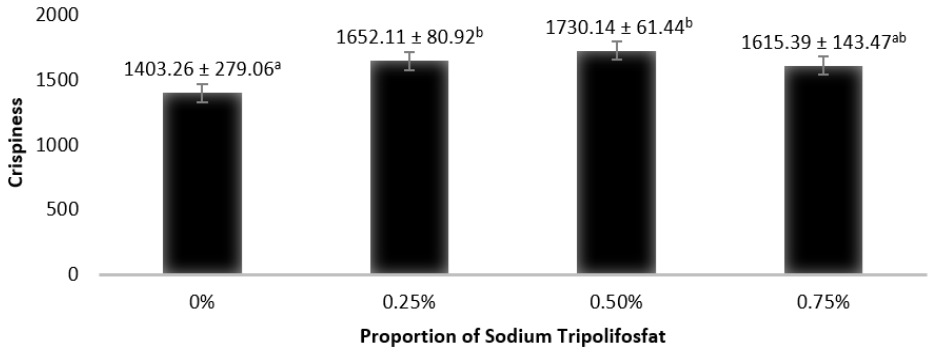

Figure 2. The crispness value of crackers with the addition of STPP is as much as 0% (T_1), 0.25% (T_2), 0.5% (T_3), dan 0.75% (T_4). Data are shown as mean ± standard deviation, in which different superscripts on the bars indicate significant differences between treatments ($p<0.05$).

3.3. Organoleptic test result

Organoleptic parameters were evaluated by 25 panelists, where the parameters tested included aroma, taste, color, crispness, and overall. The results of the organoleptic analysis of salted egg crackers are presented in Table 2. Based on organoleptic testing in taste, aroma, and overall, the highest organoleptic value was obtained in the 0.5% sodium tripolyphosphate treatment, and the lowest value was in the 0.25% treatment. In the organoleptic test results for the level of color preference and crispness, the highest value was obtained in the 0.5% treatment, and the lowest value was found in the 0% treatment. The administration of sodium tripolyphosphate had a significant effect on the taste, color, and crispness of the salted egg crackers. Overall, the panelists preferred crackers to the 0.5% STPP treatment.

The use of sodium tripolyphosphate gives a significant taste to salted egg crackers. The savory taste is obtained when using STPP at a concentration of 0.5%. STPP provides a savory taste and density, especially for foods that contain starch [25]. Whereas in terms of color, the addition of STPP to the salted egg cracker dough gave a brighter color (yellowish white), compared to the cracker mixture that was not given STPP which produced a brownish-yellow color. The addition of STPP is intended to increase color and reduce free water content which can reduce microbial growth [26]. The decrease in the value of color preference in the 0.75% treatment was also due to the increased concentration of STPP. The higher the concentration of STPP, the more phosphate groups will bind to starch, resulting in a brownish color [27].

The level of preference for salted egg crackers produced the highest value in the 0.5% treatment with a damage value of 3.96 which showed a fairly high value. The rancidity of crackers can also be seen from the TBA value in Figure 1. The lowest TBA value is 3.8 mg.mal/kg which has shown rancidity. The rancidity of crackers is also caused by storage and packaging factors that affect the oxidation of crackers. Polyethylene (PE) plastic as packaging for crackers in this research has a low density that is not airtight, thus allowing auto-oxidation to occur. The increase in total oxidation value (TOTOX) is directly proportional to storage time because oxidation in crackers can occur by auto-oxidation due to the presence of O^2 and can continue to occur during storage [28].

The low water content in the crackers also increases the crunchiness of the crackers. The highest level of crispiness of salted egg crackers is at a concentration of 0.5% and the lowest is at a concentration of 0.75%. The level of crispness of crackers will be increasingly crispy directly proportional to the level of concentration of STPP added because the expansion volume also increases [29]. However, STPP concentrations that exceed 0.5% can limit the expansion of the dough on crackers. In the treatment of the

addition of 0.75% STPP, there was a decrease in the level of preference for crispness, this was due to a decrease in swelling power. The decrease in swelling power occurs because too much STPP concentration makes starch molecules bind to phosphate from STPP rather than bind to water, thus limiting dough swelling. This causes the bonds between starch molecules with stronger hydrogen bonds so that the development of starch is limited [30].

Table 2. Salted egg crackers organoleptic test result

Parameter	Sample code (%)			
	0	0.25	0.5	0.75
Flavor	3.64 ± 1.07^{a}	3.12 ± 0.78^{abc}	4.04 ± 0.84^{b}	3.80 ± 0.91^{c}
Color	1.36 ± 0.49^{ab}	2.72 ± 0.84^{ab}	3.88 ± 0.52^{a}	3.56 ± 0.82^{b}
Scent	3.68 ± 0.85^{a}	3.52 ± 0.96^{b}	3.96 ± 0.73^{c}	3.88 ± 0.83^{d}
Crispness	3.56 ± 1.19^{a}	3.72 ± 0.94^{a}	3.76 ± 1.09^{a}	3.04 ± 0.79^{b}
Overall	2.92 ± 0.70^{a}	2.56 ± 0.58^{b}	3.12 ± 0.78^{a}	3.04 ± 0.68^{a}

Content: T_1: 0%, T_2: 0.25%, T_3: 0.5%, T_4: 0.75%. Data are shown as mean ± standard deviation where different superscripts on rows indicate significant differences between treatments ($p<0.05$)

4. CONCLUSION

The use of STPP in the salted egg cracker dough of as much as 0.5% produced a crisper product and was quite liked by the panelists because it had a savory taste, yellowish white color, and a non-rancid aroma even though it had a fair high TBA value.

ACKNOWLEDGEMENTS

All authors would like to thank the food technology laboratory, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro for providing the chemicals and equipment.

REFERENCES

[1] S. Melly, M. Harni, Y. Ernita, F. Herdian, and F. Y. Batubara, "Design of red cracker dough mixing machine for small industry development in fifty city regency in Indonesian," *IOP Conference Series: Earth and Environmental Science*, vol. 1097, no. 1, p. 012063, Oct. 2022, doi: 10.1088/1755-1315/1097/1/012063.

[2] D. Novia, E. Vebriyanti, and H. F. Hakim, "Evaluation of heating the gambier liquid waste on the quality of raw salted eggs," *International Journal of Poultry Science*, vol. 16, no. 9, pp. 369–373, Aug. 2017, doi: 10.3923/ijps.2017.369.373.

[3] Ayu Rahadiyanti, "Indonesian Food Composition Table (TKPI/DKBM) in Indonesian," *Departemen Kesehatan Republik Indonesia*, 2019. https://ahligizi.id/blog/2019/05/01/tabel-komposisi-pangan-indonesia-tkpi-terbaru/ (accessed Aug. 28, 2023).

[4] O. Olgun and A. Aygun, "Nutritional factors affecting the breaking strength of bone in laying hens," *World's Poultry Science Journal*, vol. 72, no. 4, pp. 821–832, Dec. 2016, doi: 10.1017/S0043933916000696.

[5] I. Utami, I. Santosa, R. Annisa, E. Retnaningsih, and I. Anna, "Effect ratio of milkfish payus with tapioca flour and proportion of water to organoleptic, physical and chemical characteristics of fish crackers," 2019. doi: 10.2991/icoemis-19.2019.34.

[6] P. Singh, J. Sahoo, M. K. Chatli, and A. K. Biswas, "Effect of different levels of baking powder on the physico-chemical and sensory attributes of chicken meat caruncles," *Haryana*, vol. 52, no. 1, pp. 17–21, 2013, [Online]. Available: https://rb.gy/jrhrf

[7] S. M. Nunez *et al.*, "Bovine skin gelatin hydrolysates as potential substitutes for polyphosphates: The role of degree of hydrolysis and pH on water-holding capacity," *Journal of Food Science*, vol. 85, no. 7, pp. 1988–1996, Jul. 2020, doi: 10.1111/1750-3841.15299.

[8] V. C. Resconi, D. F. Keenan, E. García, P. Allen, J. P. Kerry, and R. M. Hamill, "The effects of potato and rice starch as substitutes for phosphate in and degree of comminution on the technological, instrumental and sensory characteristics of restructured ham," *Meat Science*, vol. 121, pp. 127–134, Nov. 2016, doi: 10.1016/j.meatsci.2016.05.017.

[9] B. Yudhistira, D. R. Affandi, and Y. K. P. Artika, "Physical, chemical, and sensory characteristics of catfish karak crackers as nutrition value added," *IOP Conference Series: Earth and Environmental Science*, vol. 246, no. 1, p. 012047, May 2019, doi: 10.1088/1755-1315/246/1/012047.

[10] L. Wang, X. Liu, and J. Wang, "Structural properties of chemically modified Chinese yam starches and their films," *International Journal of Food Properties*, vol. 20, no. 6, pp. 1239–1250, Jun. 2017, doi: 10.1080/10942912.2016.1209775.

[11] T. M. Gunaratne, N. M. Gunaratne, and S. B. Navaratne, "Selection of best packaging method to extend the shelf life of rice crackers," *International Journal of Scientific & Engineering Research*, vol. 6, no. 2, pp. 638–645, 2015.

[12] R. Ramesh, R. Jeya Shakila, B. Sivaraman, P. Ganesan, and P. Velayutham, "Optimization of the gelatinization conditions to improve the expansion and crispiness of fish crackers using RSM," *Lwt*, vol. 89, pp. 248–254, Mar. 2018, doi: 10.1016/j.lwt.2017.10.045.

[13] Z. H. Kelishomi *et al.*, "Antioxidant activity of low molecular weight alginate produced by thermal treatment," *Food Chemistry*, vol. 196, pp. 897–902, Apr. 2016, doi: 10.1016/j.foodchem.2015.09.091.

[14] A. K. Umam, I. Rostini, and R. Intan, "Estimations shelf life of catfish skin crackers in polypropylene plastic packaging using the ASLT (Accelerated Shelf Life Testing) Method," *Scientific News of Pacific Region*, vol. 3, no. May, pp. 14–29, 2019.

[15] W. Z. W. Ibadullah, A. A. Idris, R. Shukri, N. A. Mustapha, N. Saari, and N. H. Z. Abedin, "Stability of fried fish crackers as influenced by packaging material and storage temperatures," *Current Research in Nutrition and Food Science Journal*, vol. 7, no. 2, Aug. 2019, doi: 10.12944/CRNFSJ.7.2.07.

[16] M. H. Tunick *et al.*, "Critical evaluation of crispy and crunchy textures: a review," *International Journal of Food Properties*, vol. 16, no. 5, pp. 949–963, Jul. 2013, doi: 10.1080/10942912.2011.573116.

[17] B. Chudasama, S. Zofair, D. Bhola, and T. Dave, "Development and Characterization of Fish Crackers Prepared From The Bull's Eye (Priacanthus hamrur, forsskal, 1775) fish meat and different starches," *Journal of Entomology and Zoology Studies*, vol. 7, no. 3, pp. 401–406, 2019.
[18] S. Hartini, A. Budi Kristanto, Y. Widi Nugrahanti, and L. Ariany Mahastanti, "Reviewing and implementing of cracker craftsmen towards healthy products with innovating various flavors (Change Bleng to STPP)," *Social Sciences*, vol. 8, no. 4, p. 185, 2019, doi: 10.11648/j.ss.20190804.16.
[19] E. Sukarminah, E. Wulandari, I. Lanti, and D. Andrasyifa, "Physicochemical characteristics of cross-link modified sorghum flour in Bandung local cultivars," *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, vol. 19, no. 3, pp. 569–576, 2019.
[20] Y. A. Arfat and S. Benjakul, "Effect of zinc sulphate on gelling properties of phosphorylated protein isolate from yellow stripe trevally," *Food Chemistry*, vol. 141, no. 3, pp. 2848–2857, Dec. 2013, doi: 10.1016/j.foodchem.2013.05.112.
[21] R. Y. Kurniasari, D. R. Affandi, B. Yudhistira, and A. P. Sanjaya, "Textural and sensory properties of little tuna fish balls (Euthynnus affinis) arrowroot flour substitutions (Maranta arundinacea Linn.) added with sodium tripolyphosphate," *IOP Conference Series: Materials Science and Engineering*, vol. 633, no. 1, p. 012050, Oct. 2019, doi: 10.1088/1757-899X/633/1/012050.
[22] Z. H. Jia *et al.*, "Effect of compound phosphate on the water-holding capacity and nutritional quality of sea bass (Lateolabrax japonicus) fillets," *Journal of Food Processing and Preservation*, vol. 46, no. 6, Jun. 2022, doi: 10.1111/jfpp.16511.
[23] D. Oktaviana and E. Saepudin, "The effect of cross-linking and fatty acid addition on the functional properties and digestibility of tapioca starch," *Journal of Physics: Conference Series*, vol. 1788, no. 1, p. 012005, Feb. 2021, doi: 10.1088/1742-6596/1788/1/012005.
[24] J. Zia, U. C. Paul, J. A. Heredia-Guerrero, A. Athanassiou, and D. Fragouli, "Low-density polyethylene/curcumin melt extruded composites with enhanced water vapor barrier and antioxidant properties for active food packaging," *Polymer*, vol. 175, pp. 137–145, Jun. 2019, doi: 10.1016/j.polymer.2019.05.012.
[25] S. Chun, E. Chambers, and D. H. Chambers, "Effects of Shiitake (Lentinus edodes P.) mushroom powder and sodium tripolyphosphate on texture and flavor of pork patties," *Foods*, vol. 9, no. 5, p. 611, May 2020, doi: 10.3390/foods9050611.
[26] J. S. Choi and K. B. Chin, "Evaluation of physicochemical and textural properties of chicken breast sausages containing various combinations of salt and sodium tripolyphosphate," *Journal of Animal Science and Technology*, vol. 62, no. 4, pp. 577–586, Jul. 2020, doi: 10.5187/jast.2020.62.4.577.
[27] J. Chen *et al.*, "Site-specific incorporation of sodium tripolyphosphate into myofibrillar protein from mantis shrimp (Oratosquilla oratoria) promotes protein crosslinking and gel network formation," *Food Chemistry*, vol. 312, p. 126113, May 2020, doi: 10.1016/j.foodchem.2019.126113.
[28] S. Zio *et al.*, "Total gossypol and oxidation levels of refined cottonseeds oils and crude peanut oils produced in Burkina Faso," *Food Research*, vol. 5, no. 6, pp. 274–282, 2021, doi: 10.26656/fr.2017.5(6).357.
[29] J. T. Kim, D. T. Utama, H. S. Jeong, and S. K. Lee, "Effect of sodium tripolyphosphate on physical quality of crispy meatball made from spent layer or broiler meat," *Nurturing Locally, Growing Globally*, vol. 364, no. 1, pp. 364–365, 2017, doi: 10.3920/978-90-8686-860-5.
[30] Y. Pranoto, Rahmayuni, Haryadi, and S. K. Rakshit, "Physicochemical properties of heat moisture treated sweet potato starches of selected Indonesian varieties," *International Food Research Journal*, vol. 21, no. 5, pp. 2031–2038, 2014.

BIOGRAPHIES OF AUTHORS

Siti Susanti is an associate professor with a demonstrated history of working in the Food Technology Department. She received her Ph.D. in 2013 from Kagawa University. Her research interest includes biotechnology food chemistry and biochemistry. She can be contacted at email: sitisusanti@live.undip.ac.id.

Rafli Zulfa Kamil is a lecturer in the Food Technology Department, at Diponegoro University. He received his PhD in 2021 from Gajah Mada University. His research interests are gut microbiota, probiotics, prebiotics, and dietary fiber.
He can be contacted at email: raflizulfakamil@lecturer.undip.ac.id

Finky Firsya Fardiah is an undergraduate student in Food Technology major in Diponegoro University. Her research is titled "The Effect of Adding Sodium Tripolyphosphate to Dough on TBA Value, Crispiness, and Organoleptic on Salted Egg Crackers". She can be contacted at email: finkyfirsyafardiah@students.undip.ac.id.