https://doi.org/10.17221/52/2021-CJFS

# Traditional puffed fish cracker ('kemplang Palembang') by microwave-oven method: Physical properties and microstructure evaluation

Guttifera[1], Laila Rahmawati[2]*, Selly Ratna Sari[1], Filli Pratama[3], Tri Wardani Widowati[3]

[1]Department of Fishery Sciences, Faculty of Agriculture, Universitas Sumatera Selatan, Palembang, Indonesia
[2]Research Center of Appropriate Technology, Indonesian Institute of Sciences, Subang, Indonesia
[3]Department of Agricultural Product Technology, Faculty of Agriculture, Universitas Sriwijaya, Indralaya, Indonesia

*Corresponding author: lail004@lipi.go.id

**Citation:** Guttifera, Rahmawati L., Sari S.R., Pratama F., Widowati T.W. (2022): Traditional puffed fish cracker ('kemplang Palembang') by microwave-oven method: Physical properties and microstructure evaluation. Czech J. Food Sci., 40: 202–209.

**Abstract:** This research has investigated the physical properties (volume expansion, texture) and microstructure of 'kemplang Palembang', traditional fish puffed crackers from Indonesia which were puffed using the microwave-oven method. The microwave-oven method was designed by the factorial randomised block design (FRBD) which contains egg addition as factors (A1 – control; A2 – egg yolk; A3 – egg white and egg yolk) and moisture factors (B1 – 7.5 ± 1%; B2 – 13.5 ± 1%). The results revealed that the egg addition and moisture were significant ($P < 0.05$) to the volume expansion and texture. Meanwhile, the microstructure of kemplang Palembang was evidenced by 3D visual analysis using the scanning electron microscopy (SEM) technique. The microstructural analysis by SEM showed that the porosity caused a significant change in volume expansion and texture. The results suggest the feasibility of adding eggs and moisture 13.5 ± 1% (A1B2 treatment) for proper volume expansion (523%), texture [156.2 gram-force (gf)], and microstructure.

**Keywords:** puffed crackers; physical evaluation; 3D visual analysis; microwave-oven heating

Kemplang is a popular traditional fish cracker from Palembang (South Sumatera, Indonesia). Kemplang is made of fish meat, tapioca flour, salt, and monosodium glutamate (Huda et al. 2010). The kemplang making process consists of several processes including dough making (mixing and moulding), steaming, slicing, drying, and frying.

Frying is a puffing process which is a crucial process in kemplang making. Frying can affect the texture and flavour of the fish crackers. To obtain specific crispness, kemplang must go through the frying process twice. The first frying stage is carried out between 80 °C and 100 °C and the second frying stage at 160 °C to 200 °C (Prasetya 2009). During kemplang frying, several chemo-physical processes take place including heat and mass transfer, protein denaturation, starch gelatinisation, colour development (Maneerote et al. 2009), loss of moisture content (Krokida et al. 2000; Saeleaw and Schleining 2011), water evaporation, and formation of the cellular structure (Bhat and Bhattacharaya 2001).

Consumer acceptance of puffed crackers such as kemplang is influenced by puff expansion and crispness. Hence, a puffing process is very crucial. Several studies have developed new technologies to improve the food quality and provide a healthier product, like using the combination of vacuum or convective drying with

https://doi.org/10.17221/52/2021-CJFS

electro-technologies for example infrared drying (Rahmawati et al. 2018) and microwave oven (Daglioglu et al. 2000; Raghavan et al. 2005). Studies that use microwave energy to puff a food product have been reported e.g. in rice (Maisont and dan Narkrugsa 2010) and popcorn (Allred-Coyle et al. 2000). However, to the best of our knowledge, the microwave oven has not been used for kemplang making yet.

The microwave oven uses microwave radiation with frequencies of electromagnetic waves ranging from 300 MHz to 300 000 MHz (Singh and Heldman 2001) to dry, cook, or heat foods (Mahmudan and Nisa 2014). The microwave oven can provide a better quality product within a shorter time, at a higher drying rate and low energy consumption (Sanga et al. 2000).

In this research, kemplang was puffed using a microwave oven. The heating process of food using microwave energy occurred because of the dipolar rotation of water molecules and food ionic components (Fu 2005). According to the previous research (Liuhartana et al. 2013) water content is one of the dominant factors in the heating process by microwaves. From preliminary research, it is known that microwave-oven puffing will cause a hard texture of puffed kemplang. For that reason, an emulsifier is added to soften the puffed kemplang texture.

This research aimed to determine the suitable treatment for puffed kemplang using a microwave-oven method. Kemplang dough was made from snakehead fish (*Channa striata*). The initial water content of dried sliced dough (raw crackers) varied, like two other factors which might affect the puffing ability of the microwave oven such as dough composition and emulsifier addition to kemplang dough. To determine the best treatment, volume expansion, texture attributes, and microstructure of puffed kemplang were compared.

## MATERIAL AND METHODS

**Sample preparation.** The snakehead fish (*C. striata*) meat was used as the main ingredient of kemplang crackers, 600 g of meat were weighed with an analytical balance (AL-204; Mettler Toledo, Switzerland). The process of making kemplang consists of several stages which are mixing and moulding into cylinders, steaming, slicing, drying, and puffing by a microwave oven (300–700 W) (MS2042D; LG, South Korea). The treatment was A1 (mixing 600 mL of water, 500 g of tapioca flour, 600 g of fish meat, and 42 g of salt), A2 (mixing 30 mL of egg yolk, 570 mL of water, 500 g tapioca flour, 600 g of fish meat, 42 g of salt), and A3 (mixing 60 mL of whole eggs, 540 mL of water, 1 500 g of tapioca flour, 600 g of fish meat, and 42 g of salt). The A1, A2, and A3 treatments were then divided into 8 parts. The second stage was moulding into cylinders (2 cm in diameter and 10 cm in length). Then the dough was steamed (100–1 100 °C for 30 min) until cooked (steamer GT 28; Maspion, Indonesia) and cooled for 36 h. After the kemplang cracker dough was cold, it was sliced (4 mm thick) (slicer knife OX-605; Oxone, Indonesia) and dried in an oven (55 °C) (UO55; Memmert, Germany) for ±18 h and ±24 h until the moisture content reached 7.5 ± 1% (B1) and 13.5 ± 1% (B2), respectively. The final stage was drying and puffing using a microwave oven (50 s) with automatic power (300–700 W).

**Hardness texture analysis.** The hardness texture of puffed kemplang was measured at the centre of the sample using a texture analyser (LFR A 7.1; Stable Micro System, United Kingdom) with a flat end cylinder probe.

**Volume expansion analysis.** The puffed kemplang was placed in a beaker glass with a known volume, the remaining space in the glass was filled with sand until the surface was flat; this volume expansion analysis method refers to Prasetya (2009).

**Scanning electron microscopy (SEM) analysis.** The microstructure of puffed kemplang was carried out by selecting the best puffed treatment and unpuffed dried slices (DS) treatment. The kemplang tested was in thin cylindrical slices. The microstructure was investigated using the scanning electron microscopy (SEM) (serial number JSM 6301F; JEOL®, Japan) with the magnification of 200, 500, and 1 000 times, the resolution of 100, 50, and 10 µm, and the depth of field 13 mm. SEM was operated with the standard operating parameters including high voltage (HV) = 10 kV; spot size (SS) = 30; working distance (WD) = ±50 µm. The data from SEM were analysed into 3D visualisation using the MountainsMap Program® 8.2.9468 (Rahmawati et al. 2020).

**Statistical analysis.** The analysis of variance (ANOVA) was performed with Statistical Package (SAS® 9.4). The statistical design, a factorial randomised block design (FRBD), was used to measure the impact of moisture content, egg addition, slice thickness and their statistical interaction.

## RESULTS AND DISCUSSION

**Volume expansion.** Expansion is the most important quality sensor of cracker product, including kemplang, which relates to consumer acceptability. The statistical analysis of volume expansion is presented in Table 1.

https://doi.org/10.17221/52/2021-CJFS

Table 1. Statistical results of physical properties of puffed kemplang

| Factor | Sample code | Volume expansion (%) | Hardness (gf) |
|---|---|---|---|
| A | A1 | 453.45[c] | 157.80[a] |
| | A2 | 152.70[a] | 336.13[b] |
| | A3 | 219.67[b] | 166.90[a] |
| B | B1 | 188.49[a] | 253.58[b] |
| | B2 | 362.47[b] | 186.98[a] |
| AB | A1B1 | 383.89[c] | 159.40[a] |
| | A2B1 | 72.80[a] | 433.07[c] |
| | A3B1 | 108.79[a] | 168.27[a] |
| | A1B2 | 523.00[d] | 156.20[a] |
| | A2B2 | 232.60[b] | 239.20[b] |
| | A3B2 | 330.54[c] | 165.53[a] |

[a–d]Different letters within columns indicate statistically significant differences ($P < 0.05$); A1 – no emulsifier; A2 – egg yolk; A3 – whole egg; B1 – 7.5 ± 1 % moisture content; B2 – 13.5 ± 1% moisture content; gf – gram-force

The A factor, B factor, and their interaction had a significant effect on the volume expansion. The smallest kemplang volume expansion was produced by A2B1 treatment, while the biggest by A1B2 treatment. The volume expansion of kemplang that was puffed using a microwave oven was influenced by the interaction between the microwave wavelength with ionic components and the polar molecules of the kemplang content. The ionic components got polarised, which was the result of ion movement interaction. On the other hand, the polar molecule can adjust the microwave field at a speed that matches the microwave frequency, hence the molecule can move fast and generate heat (Gunasekaran 2002).

Different volume expansion was caused by the addition of eggs which contain high fat and protein components, especially in egg yolks that contain 31.9% of fat and 16.3% of protein per 100 g (Directorate of Nutrition, Ministry of Health 1996). Fat content can reduce the conversion of starch during the gelatinisation process by preventing mechanical damage to the starch granules, thereby the water absorption can be avoided and kemplang can expand properly when puffed using a microwave oven. Moreover, the protein content can also influence the volume expansion of kemplang while puffed using a microwave oven.

Compared to A2, the A3 treatment had a higher volume expansion which was caused by the egg white that contains albumin that could cause food expansion (Hartono 1993). The albumin was a polar molecule that could interact with microwaves and generate more heat compared with the egg yolk. This research was in line with Alavi et al. (1999), who found that adding the egg white could increase the expansion ratio from 140% to 341%.

The B2 treatment shows a higher volume expansion than the B1 treatment due to the moisture content difference (Figure 1). The water content of B2 treatment can absorb more microwave energy than B1 treatment. This current condition can explain that the higher moisture content in the food samples will produce more heat because the water is converted into vapour pressure while interacting with microwaves (Nguyen et al. 2013). However, Nguyen et al. (2013) also stated that the product could expand properly if the appropriate moisture content was achieved. Lee et al. (2000) also confirmed that the final product was not fully puffed (dense) when the water content was above 20%. Previous research shows that the moisture content of popcorn volume expansion should be 13% to 14.5% (Ziegler et al. 1988), 13.18% (Song and Eckhoff 1994), and 15% (Swarnakar et al. 2014).

**Texture hardness.** The hardness of puffed kemplang shown in Table 1 ranged from 156.20 gram-force (gf) to 433.07 gf. The statistical analysis of hardness indicated that the A factor, B factor, and their interaction (A and B) had a significant effect on the hardness value.

The lowest hardness of kemplang was found in A1B2 treatment, followed by A1B1 treatment (Figure 2). The lowest hardness means that A1B2 treatment has the highest crispness compared to other treatments. A1B2 treatment also produced the highest volume expansion, followed by A1B1 treatment; it indicates that kemplang without emulsion could produce high volume expansion and crispness. These results are in line

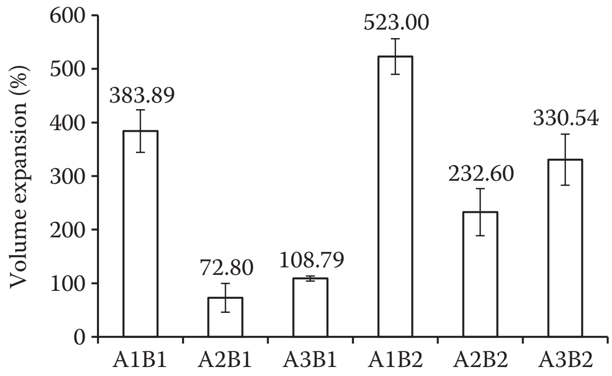


Figure 1. Volume expansion of kemplang Palembang during heating in a microwave oven

A1 – no emulsifier; A2 – egg yolk; A3 – whole egg; B1 – 7.5 ± ± 1 % moisture content; B2 – 13.5 ± 1% moisture content

https://doi.org/10.17221/52/2021-CJFS

with Siaw et al. (1985), who stated that the crispness level of a cracker has a linear expansion value higher than 77% at least.

There is a correlation between volume expansion and hardness. In addition, fish also has an important role as a protein source to affect the physical properties of kemplang. Snakehead fish which was used for making kemplang had a protein content of 16.2% (Mustafa et al. 2012). The high protein content in catfish could increase the gelatinisation process compared to the lower composition. Orban et al. (2008) mentioned that the lipid content of 1.33% in snakehead fish and 1.09–15.6% in catfish reduced the starch conversion during the gelatinisation process by preventing mechanical damage. The prevention of starch mechanical damage can inhibit the water absorption and reduce the starch conversion which affects the volume expansion while puffed using the microwave oven and creates hardness.

**Microstructure analysis.** The microstructure analysis of the food surface which was dried using the SEM method has been widely used, especially for drying products (Rahmawati et al. 2020), but there was limited literature which explains the use of a microwave oven for heating a traditional fish cracker. The SEM method was performed for the raw treatment and the best puffed treatment by microwave oven with magnifications of 200, 500, and 1 000 times and the resolution of 100, 50, and 10 μm with a depth of field 13 mm.

Figure 3 shows the microstructure of kemplang using the SEM method with magnification of 200, 500, and 1 000 times. The microstructural observation shows that the DS and microwave-oven puffed (MP) kemplang have different surface shapes and pore sizes. Using the 200 times magnification, a difference in the texture of DS and MP could be observed. DS kemplang appears to have a smooth surface, while MP kemplang has a pimply surface. Moreover, using the 500 times and 1 000 times magnification, DS kemplang appears to have smaller pores compared to MP kemplang. The differences in surface texture and pore size were affected by the volume expansion of kemplang during puffing.

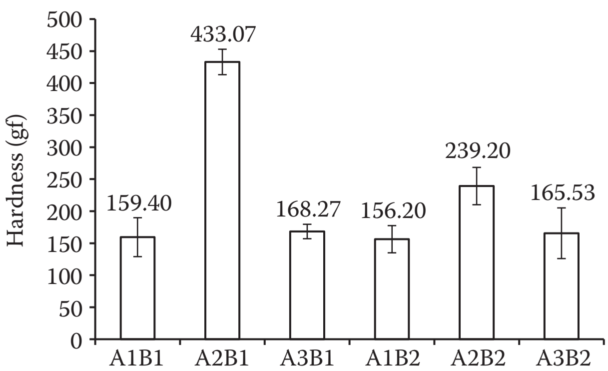


Figure 2. The texture of kemplang Palembang after heating using a microwave oven

A1 – no emulsifier; A2 – egg yolk; A3 – whole egg; B1 – 7.5 ± ± 1 % moisture content; B2 – 13.5 ± 1% moisture content

The 3D picture of kemplang microstructure was analysed using the MountainsMap software 7 (Figure 4). The analysis was done to observe the peak height, void depth, and porosity of the sample that is affected by microwave puffing. The visual results were represented in green, blue, yellow, and red colour. The green colour indicates the compact and dense surface, the blue colour indicates the porous surface, while yellow and red colours indicate that the kemplang surface was crispy due to the microwave exposure.

Figure 4 shows that MP kemplang has fewer voids and more peaks compared to DS kemplang.

The higher value of volume expansion has a correlation with the volume and thickness of voids on the kemplang surface; this state can be confirmed by the magnification of 1 000 times when the volume and thickness of voids were expanded in MP compared to DS. The kemplang formation occurs due to several factors such as high temperature, time, and vacuum process. The pores are characterised by measuring the fraction of their porosity, pore shape, pore size, pore distribution, and cell thickness (Rahman 2007). The visualisation result using the MountainsMap software 7 shows that the volume of texture voids of DS and MP was 10.92 $mm^3\ mm^{-2}$ and 9.55 $mm^3\ mm^{-2}$, respectively. The void thickness of DS was 32.7608 mm and in MP it was 28.6672 mm.

SEM magnification of 500 times shows that green and blue colours were more dominant in the raw treatment compared to the puffed kemplang using the microwave oven.

In the visual representation in Figure 4, meanwhile, the magnification of 1 000 times shows that the A1B2 treatment which has been puffed using the microwave oven was relatively dominant in red and yellow colours. The yellow and red colours could indicate that the kemplang surface is exposed to microwaves.

The porosity of surface materials can be determined by dividing the void volume by the total material (Rahmawati et al. 2020). The 1 000 times magnification and 10 μm resolution show that the porosity of the raw treatment is 72.78% and in A1B2 treatment it is 127.32%. The porosity result of the A1B2 treatment was higher due to the increased volume expansion and the crispness of texture. It is concluded that the A1B2 treatment has the highest volume expansion and crispness

https://doi.org/10.17221/52/2021-CJFS

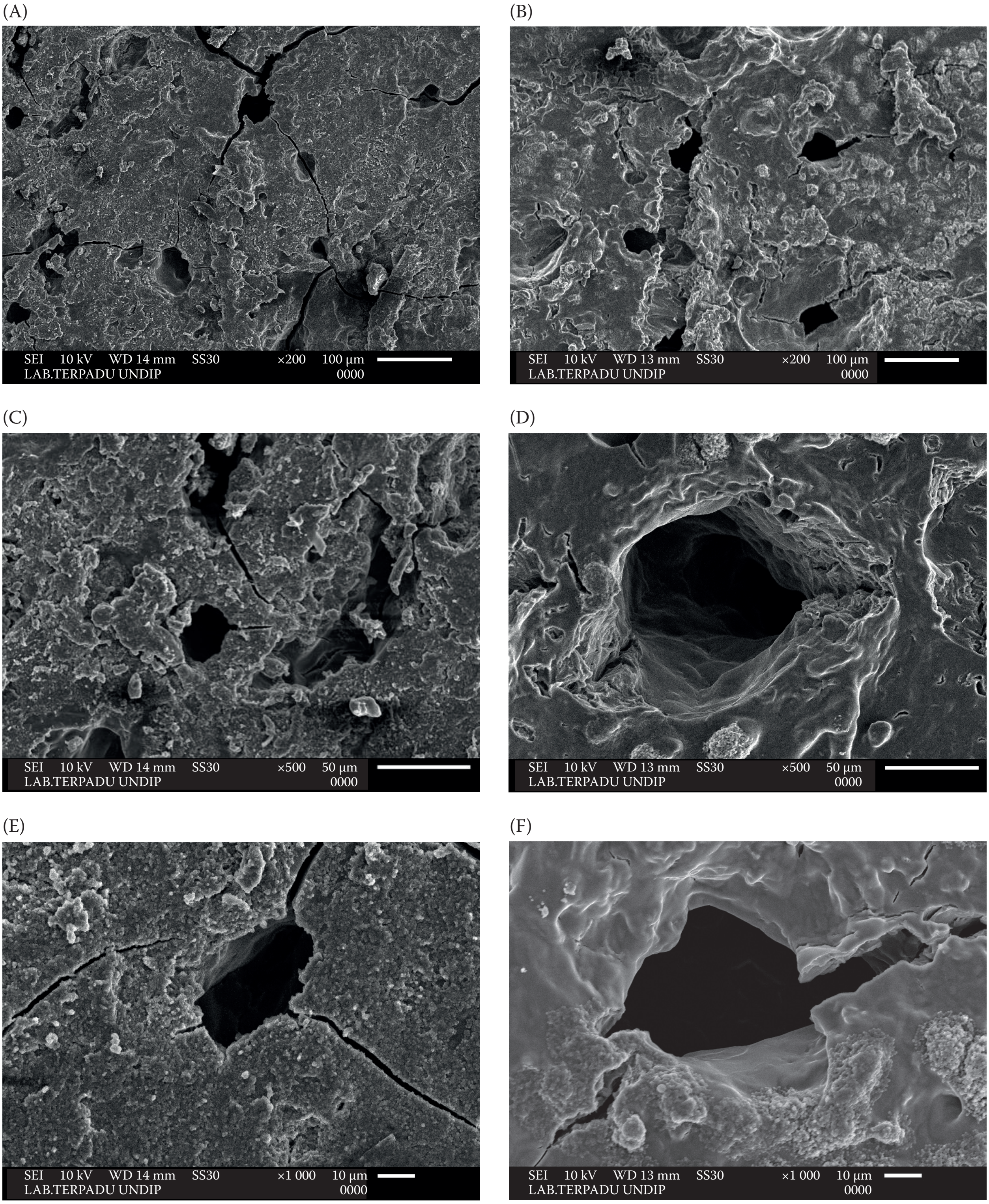


Figure 3. The scanning electron microscopy (SEM) results of kemplang Palembang: (A) raw treatment [unpuffed dried slice (DS)] (200 times of magnification), (B) A1B2 treatment [microwave-oven puffed (MP)] (200 times of magnification), (C) raw treatment (unpuffed DS) (500 times of magnification), (D) A1B2 treatment (MP) (500 times of magnification), (E) raw treatment (unpuffed DS) (1 000 times of magnification), and (F) A1B2 treatment (MP) (1 000 times of magnification)

A1 – no emulsifier; B2 – 13.5 ± 1% moisture content

https://doi.org/10.17221/52/2021-CJFS

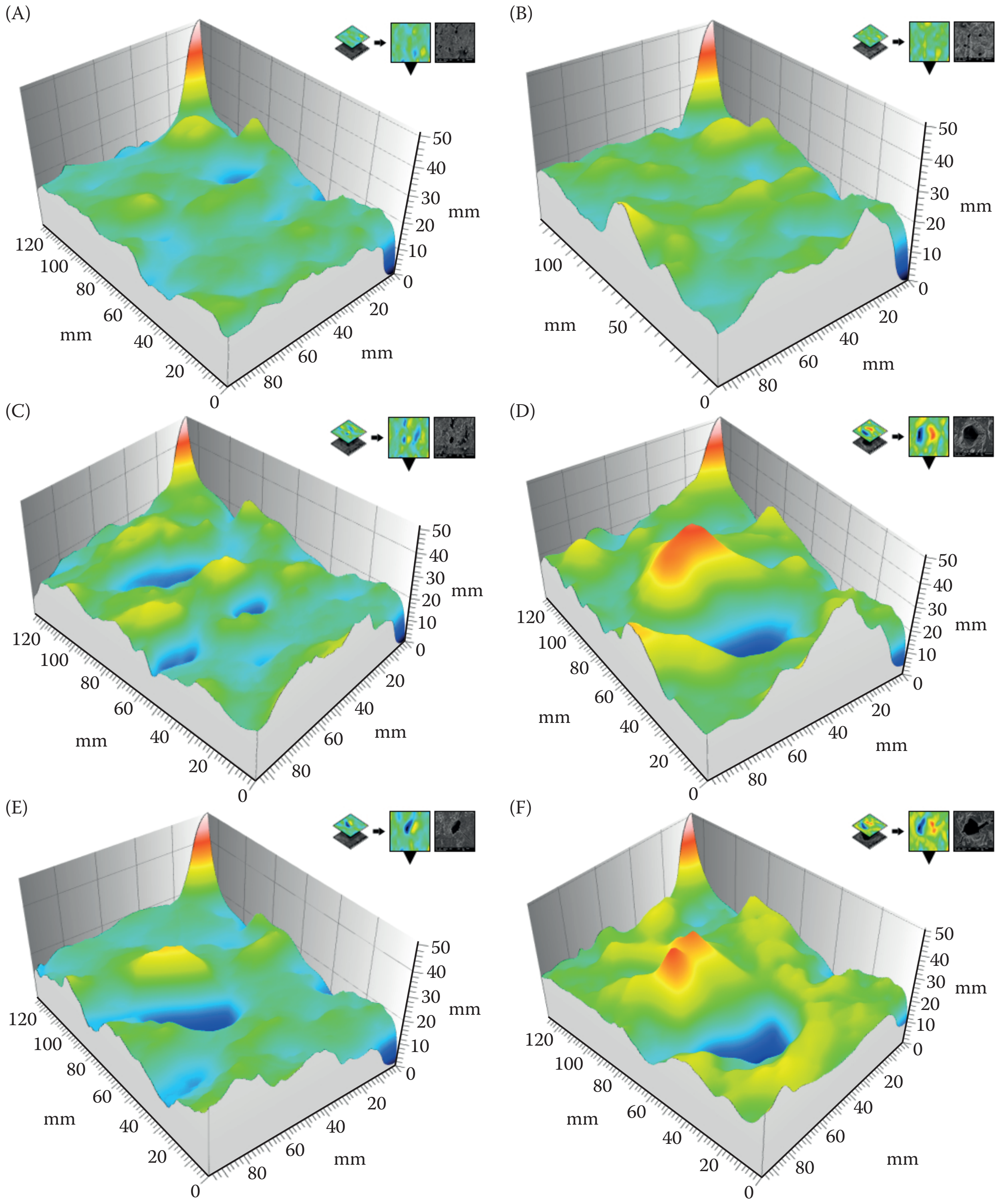


Figure 4. The 3D scanning electron microscopy (SEM) visualisation on a contour plot of kemplang Palembang: (A) raw treatment (SEM magnification of 200 times), (B) A1B2 heated treatment using microwave oven (SEM magnification of 200 times), (C) raw treatment (SEM magnification of 500 times), (D) A1B2 heated treatment using microwave oven (SEM magnification of 500 times), (E) raw treatment (SEM magnification of 1 000 times), and (F) A1B2 heated treatment using microwave oven (SEM magnification of 1 000 times)

A1 – no emulsifier; B2 – 13.5 ± 1% moisture content

https://doi.org/10.17221/52/2021-CJFS

of texture with the volume of voids 9.55 $mm^3$ $mm^{-2}$, the thickness of voids 28.6672 mm, and porosity after expansion 127.32%.

## CONCLUSION

The treatment of moisture content of 13.5 ± 1% without egg addition had the best result in the volume expansion of 523% and the best crispy texture of 157.8 gf. The visual analysis using SEM and 3D microstructural methods on the heating process using microwaves showed significant changes in the microstructure and porosity. At the 1 000 times magnification with 10 μm resolution, it was found that the A1B2 treatment had higher porosity, which was confirmed by the result of volume expansion and texture.

**Acknowledgement**. The authors gratefully acknowledge the Research Center of Appropriate Technology, Indonesian Institute of Sciences and Faculty of Fisheries Science, Universitas Sumatera Selatan for the support.

## REFERENCES

Alavi S.H., Gogoi B.K., Khan M., Bowman B.J., dan Rizvi S.S.H. (1999): Structural properties of protein-stabilized starch-based supercritical fluid extrudates. Food Research International, 32: 107–118.

Allred-Coyle T.A., Toma R.B., Reiboldt W., Thakur M., (2000): Effects of moisture content, hybrid variety, kernel size, and microwave wattage on the expansion volume of microwave popcorn. International Journal of Food Science and Nutrition, 51: 389–394.

Bhat K., Bhattacharaya S. (2001): Deep fat frying characteristics of chickpea flour suspensions. International Journal of Food Science and Technology, 36: 499–507.

Daglioglu O., Tasan M., Tuncel B. (2000): Effect of microwave and conventional baking on the oxidative stability and fatty acid composition of puff pastry. Journal of the American Oil Chemists' Society, 5: 543–545.

Directorate of Nutrition, Ministry of Health (1996): List of Food Compositions (Daftar Komposisi Bahan Makanan). Directorate of Nutrition, Ministry of Health, Republic of Indonesia. Jakarta, Indonesia, Bhratara Karya Aksara: 30–31. (in Indonesian)

Fu Z., Schroeder M.J., Shabanowitz J., Kaldis P., Togawa K., Rustgi A.K., Hunt D.F., Sturgill T.W. (2005): Activation of a nuclear Cdc2-related kinase within a mitogen-activated protein kinase-like TDY motif by autophosphorylation and cyclin-dependent protein kinase-activating kinase. Molecular Biology of the Cell, 25: 6047–6064.

Gunasekaran N. (2002): Effect of fat content and food type on heat transfer during microwaves heating. [Ph.D. Thesis]. Blacksburg, Virginia, Faculty of Virginia Polytechnic Institute and State University.

Hartono A.J. (1993): Berlecithin Emulsion and Instant Food (Emulsi dan Pangan Instan Berlisetin). Yogyakarta, Indonesia, Andi Offset Publishing: 77–80. (in Indonesian)

Huda N., Ang LL., Chung XY., Herpandi (2010): Chemical composition, colour and linear expansion properties of Malaysian commercial fish cracker (keropok). Asian Journal of Food and Agro-Industry, 3: 473–482.

Krokida M.K., Oreopoulou V., Maroulis Z.B. (2000): Effect of frying conditions on shrinkage and porosity of fried potatoes. Journal of Food Engineering, 43: 147–154.

Lee E.Y., Lim K.I., Lim J.K., Lim S.T. (2000): Effects of gelatinization and moisture content of extruded starch pellets on morphology and physical properties of microwave-expanded products. Journal Cereal Chemistry, 77: 769–773.

Liuhartana R., Priyanto G., Hamzah B. (2013): Minimal cooking time determination of pepes Nile tilapia processed by microwave oven. In: Proceeding Seminar on Climate Change and Food Scurity, Universitas Sriwijaya, Palembang, Indonesia, Oct 24–25, 2013: 163–168.

Mahmudan A.Z., Nisa F.C. (2014): The effect of frying potatoes using a microwave oven on the physical and chemical characteristics of palm oil palm (*Elaeis guineensis*) [Efek penggorengan kentang dengan oven microwave terhadap karakteristik fisik dan kimia minyak kelapa sawit sawit (*Elaeis guineensis*)]. Jurnal Pangan dan Agroindustri, 2: 151–160. (in Indonesian)

Maisont S., dan Narkrugsa W. (2010): The effect of germination on GABA content, chemical composition, total phenolics content and antioxidant capacity of Thai waxy paddy rice. Kasetsart Journal – Natural Science 44: 912–923.

Maneerote J., Noomhorm A., Takhar S.P. (2009): Optimization of processing conditions to reduce oil uptake and enhance physico-chemical properties of deep fried rice crackers. LWT – Food Science and Technology, 42: 805–812.

Mustafa A., Widodo A.M., Kristanto Y. (2012): Albumin and zinc content of snakehead fish (*Channa striata*) extract and its role in health. IEESE International Journal of Science and Technology (IJSTE), 1: 1–8.

Nguyen T.T., Le T.Q., dan Songsermpong S. (2013): Shrimp cassava cracker puffed by microwave technique: Effect of moisture and oil content on some physical characteristics. Kasetsart Journal – Natural Science, 47: 434–446.

Orban E., Teresina N., Gabriella D.L., Maurizio M., Irene C., Loretta G., Roberto C. (2008): New trends in the seafood market. Sutchi catfish (*Pangasius hypophthalmus*) fillets from Vietnam: Nutritional quality and safety aspects. Food Chemistry, 110: 383–389.

https://doi.org/10.17221/52/2021-CJFS

Prasetya H.A. (2009): The study of one-time-fried for making kemplang Palembang crackers (Kajian proses pembuatan kerupuk kemplang Palembang satu kali goreng) [Ph.D. Thesis]. Palembang, Universitas Sriwijaya. (in Indonesian)

Raghavan G.S.V., Rennie T.J., Sunjka P.S., Orsat V., Phaphuangwittayakul W., Terdtoon P. (2005): Overview of new techniques for drying biological materials with emphasis on energy aspects. Brazilian Journal of Chemical Engineering, 22: 195–201.

Rahman M.S. (2007): Toward prediction of porosity in foods during drying: A brief review. Drying Technology, 19: 1–13.

Rahmawati L., Saputra D., Sahim K., Priyanto G. (2018): Effect of infrared radiation on chemical and physical properties on Duku's peel. Potravinarstvo Slovak Journal of Food Sciences, 12: 744–755.

Rahmawati L., Saputra D., Sahim K., Priyanto G. (2020): The effect of infrared drying to the microstructural structure and texture of whole Duku intact skin by means of scanning electron microscopy (SEM) technique. Potravinarstvo Slovak Journal of Food Sciences, 14: 292–299.

Saeleaw M., Schleining G. (2011): Effect of frying parameters on crispiness and sound emission of cassava crackers. Journal of Food Engineering, 103: 229–236.

Sanga E., Mujumdar A.S., Raghavan G.S.V. (2000): Principles and application of microwave drying. In: Mujumdar A.S. (ed.): Drying Technology in Agriculture and Food Sciences. Enfield, US, Science Publishers, Inc.: 1217–1218.

Siaw C.L., Idrus A.Z., Yu S.Y. (1985): Intermediate technology for fish cracker ('keropok') production. International Journal of Food Science and Technology, 20: 17–21.

Singh R.P., Heldman D.R. (2001): Introduction to Food Engineering. 3rd Ed. Massachusetts, US, Elsevier: 337–338.

Song A., Eckhoff S.R. (1994): Optimum popping moisture content for popcorn kernels of different sizes. Cereal Chemistry, 5: 458–460.

Swarnakar A.K., Devi M.K., Das S.K. (2014): Popping characteristic of paddy using energy and optimization of process parameters. International Journal of Food Studies, 3: 45–49.

Ziegler K.E., Ashman R.B., White G.M., Wysong D.S. (1988): Popcorn production and marketing. In: National Corn Handbook. Ames, US, Iowa State University, Cooperative Extension Service: 4190–4195.

Received: February 24, 2021
Accepted: April 19, 2022
Published online: June 2, 2022