Role of formula and rice varieties on the characteristics of rice-based spring roll wrappers

by Anna Ingani Widjajaseputra

FOOD

RESEARCH

Role of formula and rice varieties on the characteristics of rice-based spring roll wrappers

*Widjajaseputra, A.I.

Faculty of Agricultural Technology-Widya Mandala Catholic University Surabaya, Dinoyo 42-44 Surabaya 60265, East Java, Indonesia

Abstract

The used formula in food processing could affect the product characteristics, including on rice-based spring roll wrappers. This research was aimed to find out an appropriate formula to get cohesive and firm mass by using four kinds of rice-based formulas on two different varieties of rice. Mentik Wangi and Ciherang varieties were used as the two preferred local rice varieties. The research used the randomized block design of nested experiment. The ingredients used for each formulation were rice flour and water (F_1); rice flour, tapioca starch and water (F_2); rice flour, egg white albumin and water (F_3) and rice flour, tapioca starch, egg white albumin and water (F_4). The weakness of rice flour is the difficulty to form cohesive mass and firm network because of its lack of gluten. The combination of egg white albumin and tapioca starch along with sufficient mechanical energy intended to carry out viscosity increasing and create an appropriate texture. The study indicated that best formula was F_4 from both of Mentik Wangi and Ciherang varieties which produced cohesive and firm mass. There was no significant difference between the two rice varieties ($P > 0.05$). The characteristics of rice-based spring roll wrapper from Mentik Wangi and Ciherang varieties were; firmness: 0.5532 ± 0.0051 N and 0.8131 ± 0.0057 N; elongation at break: $15.98\pm0.47\%$ and $16.28\pm0.29\%$ and moisture retention capacity: $38.29\pm0.12\%$ and $42.60\pm0.29\%$ respectively.

1. Introduction

Spring roll wrappers are made from wheat flour in Indonesia, but most of the wheat flour must be imported from abroad, so this research studied the product characteristics by using rice flour to substitute wheat flour in spring roll wrapper processing. There are several local of rice varieties that are available and preferred by common Indonesian society, among them, there are namely Mentik Wangi and Ciherang varieties. The base consideration of using rice flour to substitute wheat flour fresh spring roll wrapper formula was its availability. Rice flour is the most commonly used in gluten-free formulations due to it is available, easily digested, colorless and hypoallergenic (Kim *et al.*, 2015). Rice has relatively poor technological properties in interacting and developing a cohesive network (Charoenthaikij *et al.*, 2018).

Non-cohesive mass is not able to hold water well, so the use of egg whites in rice-based spring roll wrappers formula expected to increase cohesiveness with stronger protein-water interactions by heat-induced gel during heating of the batter. Egg white consisted of water (88%), protein (11%), minerals, trace of lipids and carbohydrates in around 1% (Abeyrathne *et al.*, 2013). Most of egg white proteins are globular proteins such as ovalbumin and conalbumin which require pre-heating to induce partial denaturation or opening of polypeptide chains so that three-dimensional matrix of protein gels will form a firm and cohesive mass. These characteristics will give benefit to rice-based spring roll wrapper because it can retain more water and fat in the added filling. The addition of liquid albumin to parboiled rice (15 g/100 g rice flour) create starch molecules were surrounded homogeneously by a protein network which stabilized mostly by hydrophobic interactions and disulfide bonds (Marti *et al.*, 2015). Egg white albumin begins to coagulate at 62°C and becomes very firm at temperatures higher than 70°C (Mukprasirt *et al.*, 2000). These characteristics of liquid albumin can provide stabile structure during cooking condition on 72°C for 4 mins.

Tapioca starch is the most commonly used hydrocolloid thickener because it is relatively cheap,

*Corresponding author.
Email: ingani9456@yahoo.com

abundant and it did not give any noticeable taste. Tapioca starch produces an elastic mass during gelatinization, yielding a higher cohesion. It was also reported that crumb cohesiveness increased along with increasing of starch content in the formulation containing cassava starch (Onyango *et al*., 2010).There was a certain ratio amount of egg white to tapioca starch, which have used in different gluten-free products such as (7:1) in developed gluten-free bread (Breshears and Crowe, 2013). Dacey and O'Connor (2014) reported that the composition of rice flour in ready-to-bake gluten-free pizza dough formulation is less than about 12% by weight to prevent a gritty baked pizza crust, meanwhile tapioca starch may be present in an amount from 15% to 25% by weight to get a smoother texture pizza dough. The usage of tapioca starch in the recipe may join the effect of egg white to improve the product structure as a binder (Han *et al*., 2019). Widjajaseputra *et al*. (2011) reported that tapioca, along with egg whites at the optimum ratio of rice flour to water, contributed significantly to the cohesiveness of rice-based spring-roll wrapper.

The fresh spring roll wrapper making process was based on Widjajaseputra (2010). Heating was held until the batter temperature on 72±1°C for 4 mins. The batter temperature and duration of heating have provided partially gelatinization for rice starch and complete of gelatinization for tapioca starch, so this cooking condition will produce the flexible, firm and cohesive product. Hasjim *et al*. (2013) reported gelatinization temperature range of rice flour was from 72.3°C to 82.8°C.

This research aimed to find out the best formula of rice-based spring roll wrapper which produced cohesive mass and firm enough by using four kinds of rice-based formulas of two different varieties of rice, namely Mentik Wangi and Ciherang. Characteristics of the desired rice-based spring roll wrapper should be flexible, firm and cohesive enough but it could be rolled easily.

2. Materials and methods

2.1 Materials

Rice flour from Mentik Wangi and Ciherang varieties was produced by grinding dry rice grains (without soaking) and sifted with 80 mesh sieve size. The rice flours were air-dried to get a uniform moisture level (about 5%) at 35°C for 9-10 hrs in drying oven (Venticell MMM Medcenter Einrichtungen GmbH). Leghorn chicken eggs were obtained from a local shop in Surabaya-East Java-Indonesia. The chemical composition of the rice flours and tapioca starch is shown in Table 1.

Table 1. Chemical composition of rice flours of varieties and tapioca starch (% wet basis)[a]

Component	Rice Flours		Tapioca starch
	Mentik Wangi Variety	Ciherang Variety	
Water	3.31	5.14	5
Protein	10.09	11.19	2.9
Ash	0.47	0.37	1.9
Fat	1.22	0.81	0.4
Reducing Sugar	0.22	0.36	-
Starch	80.38	80.26	86.5
Amylose Level	20.14±0.46[b]	23.0[c]	17.7[d]

[a]Widjajaseputra (2010), [b]Anugrahati *et al*. (2015), [c]Mardiah *et al*. (2016), [d] Matsunaga *et al*. (2003)

2.2 Rice-based spring roll wrapper preparation

A total of four formulas of rice-based spring roll batters were prepared using ingredients composition in Table 2 and homogenized using a magnetic stirrer with a speed of 100 rpm for 2 mins. Then, the batter was poured into a 10 cm diameter Teflon coated frying pan and heated until the temperature reached 72±1°C on an automatic stirrer hot plate set at 125°C for 4 mins. The spring rolls wrappers were measured for firmness, moisture retention capacity and elongation at break analysis.

Table 2. Formula of rice-based spring roll wrapper

Ingredients (%) [a]	Formula			
	F_1	F_2	F_3	F_4
Rice flour [b]	27	23	27	23
Tapioca starch	-	4	-	4
Egg white [c]	-	-	27	27
Pure water	73	73	46	46

[a] All ingredient percentages are given in weight/weight%
[b] Rice flour from Mentik Wangi variety or Ciherang variety
[c] Water content of egg white 88%

2.3 Viscosity analysis

Viscosity analysis was performed on the batter. About 300 mL of batter was placed in a 500 mL of beaker for viscosity measurement. The batter was heated until 72±1°C and held for 4 mins. The viscosity was determined at 35±1°C using the Brookfield Viscometer Helipath Stand LVDVE model. A total of four measurements were performed for each sample.

2.4 Firmness analysis

Firmness of the rice-based spring roll wrapper was measured using the Texture Profile Analyzer (TPA)-TA.XT type with 5 kg load cell. Samples in 20 mm x 20 mm size were put at the center of aluminium plate under the 4 mm diameter cylindrical probe. The sample was

passed by pre-test speed 1 mm/s, test speed 2 mm/s and post-test speed 2 mm/s. The distance from sample to probe was 40 mm. For this analysis, four replicates were performed.

2.5 Elongation at break measurement (%E)

Samples were prepared with 1 cm x 6 cm in size of the strip and measured by autograph (Shimadzu type AG -10TE with capacity 5 kN or 500 kgf) for elongation of break analysis. A total of four replicates were performed.

2.6 Moisture retention capacity

The moisture retention capacity of the samples was determined via the Gravimetric method (AOAC, 2010). Samples were heated at 105°C for 5 hrs in a drying oven. The dried spring rolls wrapper was divided into nine segments and for each segment, the moisture retention capacity was calculated using the following equation:

Moisture retention capacity = [Initial weight(g)– sample weight after heating (g)] / Initial weight (g) x 100%.

2.7 Experimental design and statistical analysis

The research used the randomized block design of nested experiment. Four levels of formulation (F_1, F_2, F_3, and F_4) were nested within each of two of rice varieties (Mentik Wangi and Ciherang). The experiment was carried out with four replications. Data were analyzed using the SAS (Statistical Analysis System) version 9.3 to perform ANOVA followed by a Least Significant Difference test (P $\leq$ 0.05) for means comparison.

3. Results and discussion

3.1 Batter viscosity

Based on the analysis of variance, there was no significant difference between the two of rice varieties on batter viscosity. But there were significant differences between formulas within varieties on the batter viscosity (P $\leq$ 0.05). Figure 1 shows that in both rice varieties, F_4 had the highest viscosity compared to other formulas. The increase of viscosity was due to the formation of hydrophobic interaction and hydrogen bonds between proteins and starch molecules during hydration and gelatinization processes. The starch granules swell during heating and increase the viscosity before the damage of its molecular structure. The role of rice proteins, especially glutelin (77-78% of total rice proteins) and ovalbumin from egg whites that form heat-setting gels during heating contributed to the increase of viscosity. The batter viscosities from Ciherang variety tend to be higher than batters from Mentik Wangi. These phenomena could be due to higher amylose and protein contents of Ciherang variety which were 23% and

11.19% respectively than Mentik Wangi which were 20.14% and 10.09% respectively (Table 1). The higher amylose and protein contents of Ciherang variety seemed to also affect the gelation capacity which will increase the viscosity of the batter during heating. Jeong *et al.* (2017) reported that the viscosity of lower amylose content will start to increase at lower temperatures, implying lower gelatinization temperatures. It may be due to the lower amylose starch structure was easier disrupted. Lilawattanasade and Hongsprabhas (2010) reported that protein and amylose fractions contributed their significance in the RVA (Rapid Visco Analyser) pasting profiles at separated phases. Further, it was reported that the amylose content influenced the final viscosity more that protein content of rice cultivar. Even the results suggested that rice proteins play a significant role in pasting by encasing the starch granules, restricting their swelling and increasing the shear resistance during cooking. Zhang *et al.* (2011) also reported that the increase of starch amylose content resulted in the increase of flour peak viscosity.
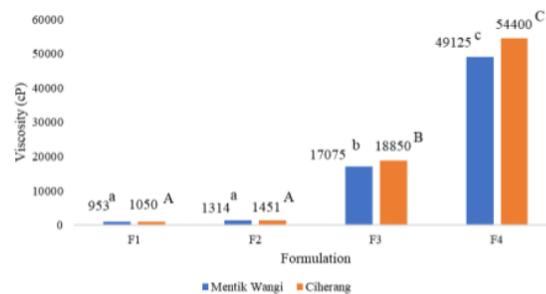

Figure 1. Viscosity of rice-based spring roll wrapper at different formulas and rice varieties. Different letters above bars indicate statistically significant difference (P < 0.05).

3.2 Firmness

Different formulas have a significant effect on the firmness of the rice-based spring roll wrappers (P $\leq$ 0.05) as shown in Figure 2. Although there was no significant effect on the firmness between the two of the varieties, F_1 had lowest firmness among both of the two varieties, Mentik Wangi and Ciherang, because this formula consisted of rice flour and water only in 27:73 weight ratio. F_2 had tapioca starch in 4% total weight, so tapioca starch gave an increasing firmness, but the formed mass was still non cohesive. The increased firmness was due to the leached amylose in the batter during heating with at 72°C and held for 4 mins. F_3 has liquid egg white albumin in the ratio 1:1 to the rice flour without tapioca starch and the firmness value was higher than F_1 and F_2 because of the effect of heat which induced gel forming of egg white albumin. When egg white albumin is heated, the hydrophobic groups for cross-link formation

by intermolecular hydrogen bonding and hydrophobic interaction will form to stabilize the gel network and strengthen the gel matrix. As a gel matrix strengthened, the product will be firmer.
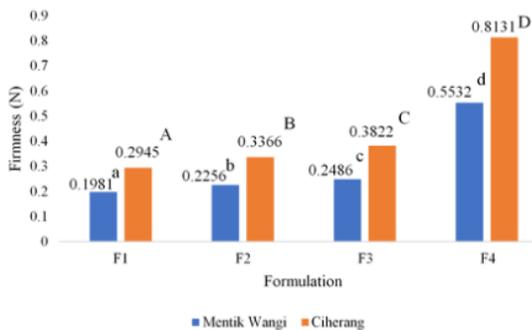

Figure 2. Firmness of rice-based spring roll wrapper at different formulas and rice varieties. Different letters above bars indicate statistically significant difference (P < 0.05).

Marti *et al.* (2014) reported that the addition of 15% liquid albumin to rice pasta gave a significant textural and appearance improvement of rice-based pasta with low cooking loss and firmer. The usage of high egg-proteins in gluten-free pasta made from parboiled rice flour improved the cooking quality because the proteins may form a denser network during cooking. It was also reported that there was increase of tensile strength, firmness, and extensibility of rice noodle with the increase of egg white proportion in amount up to 50% (w/w), while the extensibility increased with the addition of egg white in the amount of 10-30% and it decreased on higher egg white proportions in an amount of 40% and 50% (Kerdsrilek and Garnjanagoonchorn, 2014). This phenomenon was due to the formation of a rigid and fragile gel. The egg white proportion used in this study was 27% (w/w) which revealed that proper using of egg white in amount of lower than 30% produced desired firmness of rice-based spring roll wrapper.

The firmness of all investigated products of F_1, F_2, F_3, and F_4 formulas from Ciherang variety tend to be higher than that of Mentik Wangi variety. Again, this phenomenon can be linked to the high content of amylose and protein of Ciherang variety (Table 1) which is supported by Ahmed *et al.* (2016) who reported there is a positive correlation between the amylose and protein content with the firmness of noodle strands. Jeong *et al.* (2017) stated that paste made from the higher amylose level (26%) showed higher storage moduli than it was made from the lower amylose content, thus amylose level seemed to have positive contribution in firmer structure formation.

The addition of tapioca starch influenced the elastic property of rice-based foods, meanwhile rice starch showed higher dynamic moduli value compared to tapioca starch. It was due to its smaller granule size (Sun and Yoo, 2015). Further, it was reported that gel strength values of rice starch (RS) and tapioca starch (TS) blends tend to increase with an increase of amount ratio of RS (0.30 N – 0.64 N). These values were higher than the gel strength of rice starch and tapioca starch itself, 0.17±0.01 N and 0.16±0.01 N respectively. Tapioca starch, which origin from tuber roots has longer chains of glucose unit polymers than rice starch and hence, it will improve product texture by increasing the elasticity and water holding capacity in an optimal amount. The water holding capacity tends to increase with the gel strength which will improve the strength of rice-based spring roll wrapper.

3.3 Elongation at break

The elongation at break of rice-based spring roll wrapper from Mentik Wangi and Ciherang varieties was 15.98±0.47% and 16.28±0.29%, respectively, as shown in Table 3. The elongation at break of rice-based spring roll wrapper of Ciherang variety was higher than Mentik Wangi variety due to the higher protein and amylose contents of Ciherang variety than Mentik Wangi. Both protein and amylose are gel formers which affect the firmness and elasticity and contribute to the increase of elongation at break at an optimal level. This characteristic will influence the flexibility of the wrapper. The wrapper will be easier to roll. The previous research showed that the higher amylose level than 28% tended to decrease elongation at break from 14.52% to 10.96% at the level of amylose content 40% (Widjajaseputra *et al.*, 2010). It was due to the longer distance of molecular components and weakening of intermolecular bonds. Consequently, more water will be trapped in the gel system, causing it to be brittle. Tam *et al.* (2004) also reported about the optimal amylose level

Table 3. Elongation at break (%) of rice-based spring roll wrapper of formulas nested in Mentik Wangi and Ciherang varieties

Rice variety	Formulation	Elongation at break*(%)
Mentik	F_1	-
	F_2	-
	F_3	-
	F_4	15.98±0.47
Ciherang	F_1	-
	F_2	-
	F_3	-
	F_4	16.28±0.29

*The elongation at break (mean±SD%) could not be measured on F_1, F_2 and F_3 because those formulas were not able to form a cohesive mass as shown in Figure 4.

in normal maize starches with an amylose content of about 28% were successfully used to produce *bihon*-type noodle, but amylose level with 40.0-60.8% and 0.2-3.8% failed to form the noodles. Jeong *et al.* (2017) also stated that paste made from a mixture of zein and high amylose rice flours at 26% level showed greater elastic properties than a mixture of zein and rice flours with 12% and 19% amylose level.

3.4 Moisture retention capacity

Statistical analysis revealed that rice varieties were not statistically significant based on the moisture retention capacity ($P > 0.05$). Otherwise, there was a significant difference ($P \leq 0.05$) among formulas within varieties. F_4 of Mentik Wangi and Ciherang varieties retained more water compared to other formulas as shown in Figure 3. This phenomenon was due to gel system formation of F_4 by the presence of hydrophilic compounds contained in the batters.
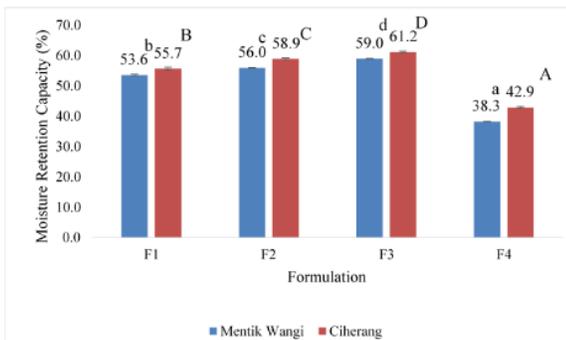

Figure 3. Moisture retention capacity (%) of rice-based spring roll wrapper at different formulas and rice varieties. Different letters above bars indicate statistically significant difference ($P < 0.05$).

In formulas containing egg white albumin, denaturation occurred and underwent coagulation to form heat-induced gel. One important function of the protein in the food system is the gelation. Gelation is the formation of a three-dimensional matrix through hydrogen bonds between proteins and allows immobilization of water in the gel structure. The interaction between starch and protein in food systems increased the gel strength as a result of increased protein matrix density and elastic starch formation (Jamilah *et al.*, 2009). This characteristic determined the binding capacity of the water by the formed gel matrix, as shown in Figure 4. Cohesive mass occurred in the rice-based spring roll wrapper of both two rice varieties of F4. It was due to the combined effect of egg white albumin and tapioca starch in the formula. The instability of the gel matrix caused low water holding capacity which occurred in a non-cohesive mass. The moisture content

reflected the ability of a product to hold entrapped water during processing. The firmness reflects the gel system stability, which depends on the type and amount of the constituent compounds. The firmness of the gel system also reflects the inter-molecular and intra-molecular bonds that occur in the presence of heating (Widjajaseputra, 2012). The addition of Egg White Protein (EWP) increased Water Holding Capacity (WHC) of duck sausage which was prepared using tapioca starch. The WHC of duck sausages was used EWP (60.00%) and without EWP (57.80%) respectively (Muthia *et al.*, 2012). It was also related to the binding properties of both egg white albumin and tapioca starch to other food components of rice-based foods. The amount of evaporated water reflects on the ability to keep the water in the gel matrix system during heating or cooking. During heating or cooking, the technological properties of rice-based food product will be improved through the gelatinization of starch and coagulation of proteins. A firmer texture, low stickiness and high shear resistance to optimally reduce the cooking loss is often preferred (Gomez and Sciarini, 2015).
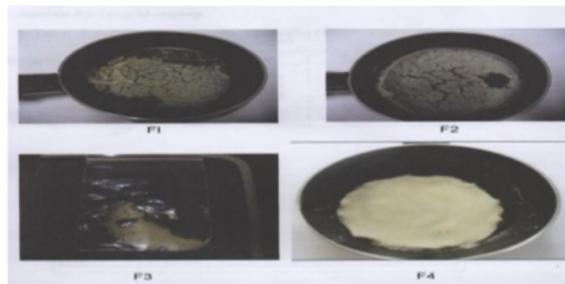

Figure 4. Photograph of several formulas of rice-based spring roll wrappers. Source: Widjajaseputra (2010)

4. Conclusion

The structure of rice-based spring roll wrapper depends on the interaction between the components of the material such as starch-water, protein-water, and starch-protein interactions. All the interactions will determine the viscosity of the batter, firmness of products and moisture retention capacity. Based on the results of this study, it can be concluded that the formula and components in each variety influenced the characteristics of rice-based spring roll wrapper especially from standpoints of firmness, elongation at break and moisture retention capacity. There was no significant difference between the two rice varieties ($P > 0.05$) as both varieties have similar intermediate-amylose rice content (20-25%). The basis of rice variety selection is the availability and consumer preference, so further investigation is needed with other basic considerations, such as different amylose classification and usage of broken rice for by-products utilization. The best-

observed formula was F_4 from both of Mentik Wangi and Ciherang varieties which produced cohesive and firm mass. The characteristics of rice-based spring roll wrapper from Mentik Wangi and Ciherang varieties have firmness: 0.5532±0.0051 N and 0.8131±0.0057 N; elongation at break: 15.67± 0.39% and 16.28± 0.29% and moisture retention capacity: 38.29 ±0.1 2% and 42.60±0.29% wet basis, respectively.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

References

Abeyrathne, E.D.N.S., Lee, H.Y. and Ahn, D.U. (2013). Egg white protein and their potential use in food processing or as nutraceutical and pharmaceutical agents – a review. *Poultry Science*, 92(12), 3292-3299. https://doi.org/10.3382/ps.2013-03391

Ahmed I., Qasi I.M., Li Z. and Ullah J. (2016). Rice Noodles: Materials, Processing and Quality Evaluation. Proceedings of the Pakistan Academy of Sciences: B. *Life and Environmental Sciences*, 53(3), 215-238.

Anugrahati, N.A., Pranoto, Y., Marsono, Y. and Marseno, D.W. (2015). In vitro digestibility of Indonesian cooked rice treated with the cooling-reheating process and coconut milk addition. *International Research Journal of Biological Sciences*, 4(12), 34-39.

AOAC. (2010). Official Methods of Analysis. Washington, DC, USA: AOAC.

Breshears, K.L. and Crowe, K.M. (2013). Sensory and textural evaluation of gluten-free bread substituted with amaranth and montina™ flour. *Journal of Food Research*, 2(4), 1-10. https://doi.org/10.5539/jfr.v2n4p1

Charoenthaikij, P., Prommin, A., Suratananun, A., Itthisophonkul, T. and Naknaen, P. (2018). Physicochemical properties and sensory quality of gluten-free brown rice pasta enriched with egg white protein. *The Journal of King Mokut's University of Technology North Bangkok*, 28(3), 627-638. https://doi.org/10.14416/j.kmutnb.2018.04.004

Dacey, M. and O'Connor, C. (2016). Ready-to-bake gluten-free pizza dough formulation. US20160150798A1. Retrieved from Google Patents website: https://patents.google.com/patent/US20160150798A1/en

Gomez, M. and Sciarini, L.S. (2015). Gluten-free bakery products and pasta. In Arranz, E., Fernandez-Banares, F., Rosell, C.M., Rodrigo, L., Pena and A.S. (Eds). Advances in the understanding of gluten-related pathology and the evolution of gluten-free foods, p. 565-604. Barcelona, Spain: OmniaScience. https://doi.org/10.3926/oms.265

Han, A., Romero, H.M., Nishijima, N., Ichimura, T., Handa, A., Xu, C. and Zhang, Y. (2019). Effect of egg white solids on the rheological properties and bread-making performance of gluten-free batter. *Food Hydrocolloids*, 87, 287-296. https://doi.org/10.1016/j.foodhyd.2018.08.022

Hasjim, J., Li, E. and Dhital S. (2013). Milling of rice grains: effects of starch/flour structures on gelatinization and pasting properties. *Carbohydrate Polymers*, 92(1), 682-690. https://doi.org/10.1016/j.carbpol.2012.09.023

Jamilah, B., Mohamed, A., Abbas, K.A., Rahman, R.A., Karim, R. and Hashim, D.M. (2009). Protein-starch interaction and their effect on thermal and rheological characteristics of a food system: A review. *Journal of Food, Agriculture and Environment,* 7(2), 169-174.

Jeong, S., Kim, M., Yoon, M.-R. and Lee, S. (2017). Preparation and characterization of gluten-free sheeted doughs and noodles with zein and rice flour containing different amylose contents. *Journal of Cereal Science*, 75, 138–142. https://doi.org/10.1016/j.jcs.2017.03.022

Kerdsrilek, A. and Garnjanagoonchorn, W. (2014). Effect of duck egg white addition on textural properties and microstructure of rice noodles. *International Food Research Journal*, 21(6), 2155-2159.

Kim, M., Yun, Y. and Jeong, Y. (2015). Effect of corn, potato, and tapioca starches on the quality of gluten-free rice bread. *Food Science and Biotechnology*, 24(3), 913-919. https://doi.org/10.1007/s10068-015-0118-8

Likitwattanasade, T. and Hongsprabhas, P. (2010). Effect of storage proteins on pasting properties and microstructure of Thai rice. *Food Research International*, 43(5), 1402-1409. https://doi.org/10.1016/j.foodres.2010.04.011

Mardiah Z., Rakhmi A.T., Indrasari S.D. and Kusbiantoro B. (2016). Grain quality evaluation to

FULL PAPER

determine consumer preference pattern of rice in Java Island, p. 163-172. Sukamandi-West Java-Indonesia: Indonesian Center for Rice Research (ICRR).

Marti, A., Barbiroli, A., Marengo, M., Fongaro, F., Iametti, S. and Pagani, M.A. (2014). Structuring and Texturing gluten-free pasta: egg albumen or whey proteins. *European Food Research and Technology*, 238, 217-224. https://doi.org/10.1007/s00217-013-2097-4

Matsunaga, K., Kawasaki, S. and Takeda, Y. (2003). Influence of physicochemical properties of starch on crispness of tempura fried batter. *Cereal Chemistry*, 80(3), 339-345. https://doi.org/10.1094/CCHEM.2003.80.3.339

Mukprasirt, A., Herald, T.J. and Flores, R.A. (2000). Rheological characterization of rice flour-based batters. *Journal of Food Science,* 65(7), 1194-1199. https://doi.org/10.1111/j.1365-2621.2000.tb10264.x

Muthia, D., Huda, N. and Ismail, N. (2012). The effect of egg white powder addition with tapioca and sago flours on physicochemical and sensory properties of duck sausage. *International Food Research Journal*, 19(4), 1415-1421.

Onyango, C., Mutungi, C., Unbenhend, G. and Lindhauer, M.G. (2010). Modification of Gluten-free SorghumBatter and Bread Using Maize, Potato, Cassava or Rice Starch. *LWT-Food Science and Technology*, 44(3), 681-686. https://doi.org/10.1016/j.lwt.2010.09.006

Sun, D. and Yoo, B. (2015). Effect of tapioca starch addition on rheological, thermal, and gelling properties of rice starch. *LWT – Food Science and Technology*, 64(1), 205–211. https://doi.org/10.1016/j.lwt.2015.05.062

Tam, L.M., Corke, H., Tan, W.T., Li, J. and Collado, L.S. (2004). Production of bihon-type noodles from maize starch differing in amylose content. *Cereal Chemistry*, 81(4), 475-480. https://doi.org/10.1094/CCHEM.2004.81.4.475

Widjajaseputra, A.I. (2010). The role of amylose and several processing conditions on characteristics of fresh rice-based spring rolls wrappers. Malang, Indonesia: Brawijaya University, PhD Thesis.

Widjajaseputra, A.I., Harijono, Yunianta and Estiasih, T. (2010). The role of amylose and tempering time on characteristics of fresh rice-based spring rolls wrappers. Proceedings of 2nd International Conference on Biosciences and Biotechnology. Denpasar-Bali, Indonesia: Udayana University Press -Udayana University

Widjajaseputra, A.I., Harijono, Yunianta and Estiasih, T.

(2011). Effect of flour to water ratio on characteristics of fresh rice-based spring rolls wrappers. *Journal of Technology and Food Industry*, 22(3), 184-189.

Widjajaseputra, A. (2012). Relation of moisture distribution and texture of rice-based foods-a perspective. *International Food Research Journal*, 19(3), 1275-1278.

Zhang, S.B., Lu, Q.Y., Yang, H. and Meng, D.D. (2011). Effects of protein content, glutenin-to gliadin ratio, amylose content, and starch damage on textural properties of Chinese fresh white noodles. *Cereal Chemistry*, 88(3), 296-301. https://doi.org/10.1094/CCHEM-05-10-0072

Role of formula and rice varieties on the characteristics of rice-based spring roll wrappers

7   Teerarat Likitwattanasade, Parichat Hongsprabhas. "Effect of storage proteins on pasting properties and microstructure of Thai rice", Food Research International, 2010
Publication

%1

8   chimie-biologie.ubm.ro
Internet Source

%1

9   scien.net
Internet Source

<%1

10   repositorium.sdum.uminho.pt
Internet Source

<%1

11   www.thieme-connect.com
Internet Source

<%1

12   espace.library.uq.edu.au
Internet Source

<%1

13   Xiao-Na Guo, Feng Gao, Ke-Xue Zhu. "Effect of fresh egg white addition on the quality characteristics and protein aggregation of oat noodles", Food Chemistry, 2020
Publication

<%1

14   Submitted to University of Keele
Student Paper

<%1

15   Submitted to Fakultas Ekonomi dan Bisnis Universitas Gadjah Mada
Student Paper

<%1

16 mafiadoc.com
Internet Source
<%1

17 www.isfae.org
Internet Source
<%1

18 Onyango, C.. "Modification of gluten-free sorghum batter and bread using maize, potato, cassava or rice starch", LWT - Food Science and Technology, 201104
Publication
<%1

19 www.spandidos-publications.com
Internet Source
<%1

20 clinics.org.br
Internet Source
<%1

21 docplayer.net
Internet Source
<%1

22 www.foodrheologysymposium.com
Internet Source
<%1

23 Matsunaga, Kotaro, Sadamichi Kawasaki, and Yasuhito Takeda. "Influence of Physicochemical Properties of Starch on Crispness of Tempura Fried Batter", Cereal Chemistry, 2003.
Publication
<%1

24 www.ifrj.upm.edu.my
Internet Source
<%1