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To cite this article: L E Yulianti *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **251** 012037

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Addition of Tempeh Flour as a Protein Source in Mixed Flour (Mocaf, Rice, and Corn) for Pasta Product

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Abstract. Mocaf (modified cassava flour), rice flour, and corn flour were used as mixed flour to prepare pasta product. Various levels of tempeh flour (0%, 2.5%, 5%, 7.5%, 10%, 12.5% and 15%) were incorporated to enrich nutritional content of the mixed flour, primarily protein. This current work aimed to understand the effect of tempeh flour addition on physicochemical characteristics (moisture content, ash content, protein content, fat content and whiteness level) and pasting properties of the mixed flour. The results showed that addition of tempeh flour did not exhibit significant impacts to moisture (9.17-10.18%), ash (0.74-0.91%), and fat content (4.68-5.65%) of the mixed flour. On the other hand, it produced significant effects on protein level, white degree and pasting properties at a significance level of 5%. In the absence of tempeh flour, protein level and whiteness level of the mixed flour reached 5.83% and 80.96%, respectively. Meanwhile, tempeh flour could increase protein content of 6.30-9.07% and alter whiteness level of 66.08-71.97%. In addition, the presence of tempeh flour was also found to improve viscosity in comparison with control. The protein level was higher as more tempeh flour was added, while whiteness level and viscosity appeared to decrease. Addition of 5% tempeh flour increased protein content to 6.88%, and the mixed flour has the best viscosity.

Keywords: mixed flour, tempeh flour, physicochemical, pasting properties

1. Introduction

Noodle is one of the pasta products and constitutes an alternative source of carbohydrate for Indonesian people. Noodle consumed in Indonesia is mostly made of wheat flour, which provokes noticeable threats to food security considering that the wheat was not massively cultivated in Indonesia. Demand on wheat flour seems to be increased, resulting in the dependence on the importation. Therefore, numerous efforts have been made to explore the use of alternative source for substituting wheat flour; this is expected to reduce wheat dependence. Besides, there is a growing demand for gluten-free products including noodle [1].

Indonesia is endowed with local natural sources that can be developed for food ingredients. These potential sources of carbohydrate, i.e., cassava, rice, and corn, are reported to be the most abundant in Indonesia. In 2015, their production reached 21,801,415 tons, 75,397,841 tons and 19,612,435 tons, respectively [2]. They have been widely used for intermediate food products such as mocaf (modified cassava flour) through the fermentation process, rice flour, and corn flour.

The search for alternative source of wheat flour in noodle production has been investigated. Sabbatini *et al.* [3] developed noodle made of cassava starch, rice flour, and cornstarch with the



addition of gum 2% as a hydrocolloid. Pato *et al.* [4] reported the production of noodle made of cassava flour (55%) and corn flour (45%) that corresponds to the national standard of instant noodle (SNI 01-3551-2000) except protein content.

The protein content of food could be improved through incorporating protein-rich components, such as tempeh which is well-known as a fermented soybean. Previous study reported that fermented soybean had better nutritional content due to enzymatic activity generated by tempeh starters (mold). The action of the enzyme could degrade protein into more digestible fragments in intestine in comparison with non-fermented soybean [5]. This research aimed to uncover the effects of tempeh flour addition on physical, chemical and pasting properties of the mixed flour (mocaf, rice, and corn flour) used for pasta noodle.

2. Materials and Methods

2.1. Raw materials

The main ingredients included tempeh flour, mocaf, rice flour, and corn flour. Mocaf was supplied from small and medium enterprise (SMEs) Tanjungsang in Subang, while the rest (tempeh flour, rice flour, and corn flour) was prepared in Laboratory of Food, Development Center for Appropriate Technology.

To make tempeh flour, tempeh was first made through fermenting soybean for 48 h. Tempeh was sliced and dried using infra-red drier at 40-45 °C for 4-5 h. The dried tempeh was ground using disc mill and sieved to form a flour. The rice flour was made by soaking rice grains for 1 h. Afterward, the soaked rice grains were drained and then air-dried. The dried rice grains were ground using disc mill and dried to reach a moisture content of no more than 10%. Corn flour was made by using dry milling method. The milling process was carried out twice. The first milling was performed using a chopper machine to produce grits, pericarp, germ and tip cap. Only grits were used in a further step. The grits were washed and soaked in water for 3-4 h to soften them, enabling to easier milling process. The second milling (fine) was performed by using a disc mill. Corn flour and rice flour were sieved in 40-mesh.

2.2. Procedures

2.2.1. Formulation of mixed flour

The composite flour was made by mixing the raw materials as the following percentage: mocaf (40%), rice flour (35%) and corn flour (25%). The composite flour was then added with tempeh flour at 7 levels and performed at triplicate.

Table 1. Concentration levels of tempeh flour

Formula code	Tempeh flour concentrations (%)
K (control)	0
M1	2.5
M2	5
M3	7.5
M4	10
M5	12.5
M6	15

2.2.2. Analysis of mixed flour

The chemical analysis was carried out, including moisture, ash, protein, and fat. Determination of moisture and ash content was performed using an approved method by national standard (SNI 01-2891-1992). Meanwhile, protein content was determined using Dumas combustion method using DuMaster Buchi D-480, Switzerland. The fat content was analyzed using Soxhlet with hexane as a solvent.

Physical characteristics of the flour (L^* , a^* , b^*) were determined using NH_3 colorimeter. The whiteness level was obtained through calculation using the following formula: $100 - [(100 - L^*)^2 + a^{*2} + b^{*2}]^{1/2}$ [6]. Pasting properties was performed using Rapid Viscosity Analyzer (RVA-TecMaster).

Data were evaluated using One-way Analysis of Variance (ANOVA) in SPSS software. Significant difference between means was compared using Duncan Multiple Range Test (DMRT) at significance level of 5% ($p \leq 0.05$).

3. Result and Discussion

3.1. Chemical characteristics of mocaf, rice flour, and corn flour

Raw materials for mixed flour included mocaf, rice flour, and corn flour. Tempeh flour was added to enrich protein level of mixed flour. The chemical profile of each flour is presented in Table 2.

Table 2. Chemical profile of mixed flour raw materials

Parameter	Mocaf*	Rice Flour*	Corn Flour*	Tempeh Flour
Moisture Content (%)	10.62	5.05	6.05	6.50
Ash Content (%)	1.29	0.27	0.48	2.20
Protein Content (%)	1.77	10.07	7.07	45.43

(*): source by Afifah and Ratnawati [7]

As a result, moisture content of each was less than 11%, in which mocaf was observed to have the highest percentage. According to SNI, the maximum level of rice flour moisture and ash is 13% and 1.0%, respectively (SNI 3549-2009), as also attributed to mocaf, i.e., 13% and 1.5% (SNI 7622-2011), and corn flour, i.e., 10% and 1.5% (SNI 01-3727-1995). This suggests that the moisture and ash content of those flours is acceptable based on SNI.

Tempeh flour was found to have higher ash content compared to other flours, and it is also rich in protein. Tempeh is a processed soybean product after fermented using *Rhizopus oligosporus*. Wang *et al.* [8] asserted that total amino acids in tempeh were drastically increased up to 3-10 times higher compared to soybean. This is due to roles of *R. oligosporus* capable of hydrolyzing protein to form amino acids and peptides, leading to enhancement of nutritional content of tempeh.

3.2. Chemical characteristics of mixed flour

Mocaf, rice flour, corn flour and tempeh flour at various concentrations were mixed. The chemical characteristics of mixed flour are presented in Table 3.

Table 3. Chemical characteristics of mixed flour with the addition of tempeh flour

Formula Code	Moisture Content (%)	Ash Content (%)	Protein Content (%)	Fat Content (%)
K	10.18 ^a ± 0.24	0.91 ^a ± 0.05	5.83 ^a ± 0.05	5.22 ^{ab} ± 0.11
M1	9.89 ^{ab} ± 0.11	0.89 ^a ± 0.05	6.30 ^b ± 0.03	5.19 ^{ab} ± 0.15
M2	9.95 ^{ab} ± 0.51	0.82 ^a ± 0.05	6.88 ^c ± 0.05	5.65 ^a ± 0.11
M3	9.17 ^b ± 0.19	0.87 ^a ± 0.07	7.24 ^d ± 0.05	4.91 ^{ab} ± 0.52
M4	9.85 ^{ab} ± 0.89	0.81 ^a ± 0.01	8.03 ^c ± 0.11	4.68 ^b ± 0.17
M5	9.41 ^{ab} ± 0.14	0.83 ^a ± 0.01	8.43 ^f ± 0.11	4.85 ^{ab} ± 0.04
M6	9.93 ^{ab} ± 0.14	0.74 ^a ± 0.03	9.07 ^g ± 0.17	5.33 ^{ab} ± 0.24

Means with different letters in the same column differ significantly at $p \leq 0.05$

3.2.1. Moisture content

Moisture content is defined as the amount of water present in a material and expressed as a percentage. The moisture content of flour constitutes a considerable parameter in relation to flour storability. As presented in Table 3, the moisture content of sample K (without the addition of tempeh flour, 0%) was significantly different from sample M3 (tempeh flour 7.5%) but not different in comparison with other samples.

The moisture content of sample K was 10.18%, while other samples contained moisture content ranging from 9.17% to 9.93%. This suggests that addition of tempeh flour could reduce the moisture content of composite flour since it possessed lower content of water than other flours (mocaf, rice

flour, corn flour). As reported by Murni [9], the addition of tempeh flour attenuated moisture content of chicken nugget.

3.2.2. Ash content

Ash content is one of important parameters capable of representing the level of inorganic components (mineral) in a product. It positively correlates to the abundance of inorganic components [10]. Tempe is found to contain both micro and macro minerals such as Ca, P, Fe, Mg, Cu and Zn [5].

As presented in Table 3, the highest ash content was attributed to the sample K, while the lowest one was found in composite flour added with tempeh flour 15%. This is not different statistically at $p \leq 0.05$.

3.2.3. Protein content

An increase in protein content is expected after incorporating tempeh flour, considering that protein is considered as important nutrition for infants [11-12]. The results exhibited that protein level of variously mixed flours ranged from 5.83% to 9.07%, which was statistically significant at $p \leq 0.05$.

Sample K, without the addition of tempeh flour, was observed to have the lowest protein level, while the highest one was attributed to mixed flour added with tempeh flour 15%. Protein level was higher as more tempeh flour was incorporated. This is in accordance with Aini *et al.* [13], finding that higher protein level of white corn noodle occurred along with an increase in substitution by tempeh flour. Lailiyati *et al.* [14] also reported that addition of Tempeh flour 20% could enhance protein content of corn rice.

Addition of tempeh flour appears to elevate protein content of mixed flour due to a high protein content of tempeh flour reaching 45%. Babu *et al.* [15] found that the abundance of amino acids in Tempeh which is comparable to either red meat or poultry meat.

3.2.4. Fat content

Fat has a pivotal role as an energy source and also affects texture of food as well as its organoleptic performance. Fat content in mixed flour ranged from 4.68% to 5.65%. Enrichment using tempeh flour seems to unaffected fat content of the mixed flour, according to statistical evaluation at $p \leq 0.05$, except between sample M2 (tempeh flour 5%) and sample M4 (tempeh flour 10%).

The fat content in tempeh is less than soybean since lipase hydrolyzes triacylglycerol into fatty acids during fermentation process. The fatty acid, a hydrolytic product of lipase activity, is utilized by molds to generate energy, thus lowering fat content in tempeh. As reported by a previous study, fermentation accounts for the reduction of fat content up to 26% [5].

3.3. Physical characteristics of mixed flour

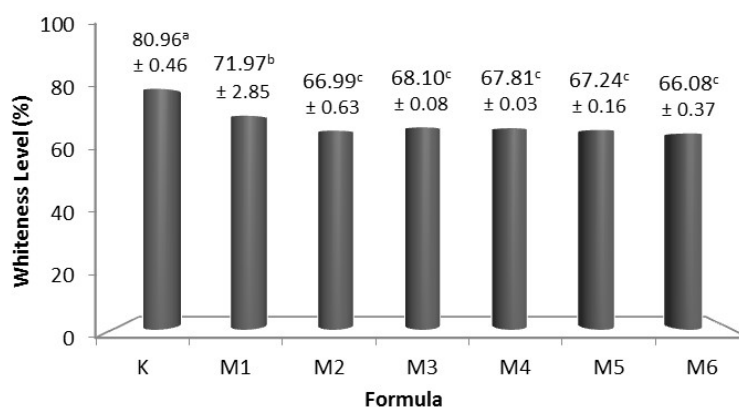


Figure 1. Whiteness level of mixed flour with the addition of tempeh flour

In this experiment, color is evaluated since it serves a noticeable attribute in food industry. Whiteness level refers to color indices commonly used to evaluate flour quality and is considered a major

parameter for flour-based ingredients. It may also represent the ability of flour to reflect light coming to its surface [16]. The higher degree of whiteness is more desirable in flour.

The whiteness level of mixed flour ranged from 66.08% to 80.96%. The highest whiteness level was found in sample K, while the lowest one was attributed to the sample M6 (tempeh flour 15%). The results showed a significant difference between sample K, M1, and from sample M2 to sample M6. In contrast, the whiteness level of the sample from M2 to M6 was not significantly different.

These results suggested that incorporation of tempeh flour negatively related to whiteness. Aini *et al.* [13] reported that an increase in tempeh flour proportion could increase brown color intensity of corn noodle. Tempeh flour was also reported to decrease lightness of crackers [17].

3.4. Pasting properties of mixed flour

Paste profile of the flour was evaluated regarding the viscosity increment during heat exposure due to irreversible granular swelling in water [18]. The pasting properties of flour included pasting temperature (PT), peak viscosity (PV), hot paste viscosity (HPV), breakdown viscosity (BV), final viscosity (FV), and setback viscosity (SV). Table 4 indicates that there is a significant difference in paste profile ($p \leq 0.05$). In general, the addition of tempeh flour affected pasting properties of the composite flour.

Table 4. Pasting properties of mixed flour

Formula Code	Pasting Temp / PT (°C)	Peak Viscosity / PV (cP)	Hot Paste Viscosity / HPV (cP)	Breakdown Viscosity / BDV (cP)	Final Viscosity / FV (cP)	Setback Viscosity / SBV (cP)
K	75.0 ^d ± 0.0	2997 ^{ab} ± 58	2753 ^{bc} ± 99	262 ^{ab} ± 6	3477 ^c ± 86	742 ^c ± 28
M1	75.5 ^d ± 0.3	3237 ^a ± 219	2934 ^{ab} ± 206	303 ^a ± 41	4158 ^b ± 250	1224 ^b ± 143
M2	76.7 ^c ± 0.2	3257 ^a ± 214	3053 ^a ± 174	222 ^b ± 26	4737 ^a ± 157	1702 ^a ± 68
M3	79.4 ^{ab} ± 0.4	2862 ^{bc} ± 110	2580 ^{cd} ± 96	282 ^{ab} ± 12	4110 ^b ± 60	1530 ^a ± 14
M4	78.9 ^b ± 0.5	2915 ^{bc} ± 154	2608 ^{cd} ± 186	307 ^a ± 18	3895 ^{bc} ± 190	1287 ^b ± 88
M5	80.1 ^a ± 0.4	2699 ^c ± 80	2395 ^d ± 107	304 ^a ± 23	3539 ^c ± 53	1144 ^b ± 76
M6	80.4 ^a ± 0.2	2828 ^{bc} ± 73	2529 ^{cd} ± 67	299 ^a ± 7	3596 ^c ± 51	1067 ^b ± 12

Means with different letters in the same column differ significantly at $p \leq 0.05$

Based on Table 4, a remarkable change of pasting properties was observed after treatment of tempeh flour. Pasting temperature (PT) appeared to be higher with an increasing tempeh flour level. PT refers to a minimum temperature required to induce gelatinization. The lowest PT was observed in sample K, while the highest one was attributed to the sample M6. Richana and Sunarti [18] stated that PT was influenced by some factors such as the molecular size of amylose and amylopectin and heating condition. The protein in tempeh flour could form complex with amylose, thus generating insoluble sediment and inhibiting amylose release from granule. Presence of tempeh flour leads to a higher PT since more energy required to release amylose (gelatinization process).

The results showed that a higher proportion of tempeh flour seemed to decrease the value of pasting properties as observed in PV, HPV, BDV, FV, and SBV. As reported by Julianti *et al.* [19] and Tharise *et al.* [20], the greater proportion of tempeh flour reduced PV, HPV, BDV, FV, and SBV. Jane *et al.* [21] found that content of amylose, protein, fat negatively correlated to viscosity. Protein content of mixed flour was higher due to greater proportion of tempeh flour. The increasing protein level caused a reduction of viscosity of mixed flour.

Table 4 exhibits that addition of tempeh flour induced higher PV, HPV, BDV, FV, and SBV than sample K. Sample M2 (tempeh flour 5%) was found to have the highest PV, HPV, FV and SBV in comparison with other samples. The high PV, HPV, FV, and SBV of the samples indicate that they could induce proper gelling formation and retain it during cooling stage. The high HPV could indicate low cooking loss and superior eating quality [22].

4. Conclusion

The addition of tempeh flour to mixed flours had effects on their protein content, whiteness, and pasting properties. The greater proportion of tempeh flour increased protein level, but decreased whiteness level and viscosity of the mixed flour. The protein content of sample K was 5.83%, while

the presence of tempeh flour could increase protein level up to 6.30% - 9.07%. The whiteness level of sample K reached 80.96%, which was higher than that of mixed flour added with tempeh flour, ranging from 66.08% to 71.97%. The mixed flour enriched with tempeh flour has a better viscosity compared to sample K. The viscosity of mixed flour was higher as more tempeh flour was added. Addition of 5% tempeh flour increased protein content to 6.88%, and the mixed flour has the best viscosity.

5. Acknowledgment

The authors greatly thank those have supported this research, especially to The Ministry of Research Technology and Higher Education of the Republic of Indonesia for funding this research.

6. References

- [1] Jeong S, Kim HW and Lee S 2016 Rheological and secondary structural characterization of rice flour-zein composites for noodles slit from gluten-free sheeted dough *Food. Chem.*
- [2] Badan Pusat Statistik 2017 <https://www.bps.go.id/site/resultTab>
- [3] Sabbatini SB, Sanchez HD, Torre MA and Osella CA 2014 Design of a premix for making gluten free noodles *Int. J. Nutr. Food. Sci.* **3** (5) 488-92
- [4] Pato U, Yusuf Y, Isnaini RF, Dira DM 2016 The quality of instant noodle made from local corn flour and tapioca flour *J. Adv. Agr. Tech.* **3**(2) 118-23
- [5] Astuti M, Meliala A, Dalais FS and Wahlqvist ML 2000 Tempe , a nutritious and healthy food from Indonesia *Asia. Pas. J. Clin. Nutr* **9** 322-25
- [6] Mawarni RT, Widjanarko SB 2015 Penggilingan metode ball mill dengan pemurnian kimia terhadap penurunan oksalat tepung porang *J. Pangan Agr.* **3**(2) 571-81
- [7] Afifah N and Ratnawati L 2017 Quality assessment of dry noodles made from blend of mocaf flour, rice flour and corn flour *Proc. IOP Conf. Ser.: Earth Environ. Sci.*
- [8] Wang HL, Ruttle DL and Hesseltine CW 1968 Protein quality of wheat and soybeans after *Rhizopus oligosporus* fermentation *J. Nutr.* **96** 109-14
- [9] Murni M 2014 Pengaruh penambahan tepung tempe terhadap kualitas dan citarasa naget ayam *Berita Litbang Industri* **3** (2) 117-23
- [10] Bastian F, Ishak E, Tawali Ab and Bilang M 2012 Daya terima dan kandungan zat gizi formula tepung tempe dnegan penambahan semi refined carrageenan (SRC) dan bubuk kakao *J. Apl. Tek. Pangan* **2**(1) 5-8
- [11] Ernawati F, Rosmalina Y and Permanasari Y 2013 Pengaruh asupan protein ibu hamil dan panjang badan bayi lahir terhadap kejadian stunting pada anak usia 12 bulan di Kabupaten Bogor *Penelitian Gizi dan Makanan* **36** (1) 1-11
- [12] Anindita P 2012 Hubungan tingkat pendidikan ibu, pendapatan keluarga, kecukupan protein dan zinc dengan stunting pada balita usia 6-35 bulan di Kecamatan Tembalang Kota Semarang *J. Kes. Masy* **1**(2) 617-26
- [13] Aini N, Prihananto V dan Munarso J 2012 Characteristics of white corn noodle substituted by tempeh flour *J. Teknol. Ind. Pangan* **23** (2) 179-85
- [14] Lailiyati SN, Rahmawanti D and Andriani MAM 2014 Formulasi dan kajian karakteristik nasi jagung (*Zea mays* L) instan dengan penambahan tepung tempe *J. Teknosains Pangan* **3** (1) 155-63
- [15] Babu PD, Bhakayaraj R and Vidhyalakshmi R 2009 A low cost nutritious food 'Tempeh' - a review *World J. Dairy Food Sci.* **4** (1) 22-27
- [16] Gilang R, Affandi DR and Ishartani D 2013 Karakteristik fisik dan kimia tepung koro pedang (*Canavalia ensiformis*) dengan variasi perlakuan pendahuluan *J. Teknosains Pangan* **2**(3) 34-42
- [17] Mustakim, Yusmarini and Herawati N 2016 Pemanfaatan tepung jagung dan tepung tempe dalam pembuatan kerupuk *J. Faperta* **3** (2)
- [18] Richana N and Sunarti TC 2004 Karakterisasi sifat fisikokimia tepung umbi dan tepung pati dari umbi ganyong, suweg, ubi kelapa dan gembili *J. Pascapanen* **1** (1) 29-37

- [19] Julianti E, Rusmarilin H, Ridwansyah and Yusraini E 2015 Functional and rheological properties of composite flour from sweet potato, maize, soybean and xanthan gum *J. Saudi Soc. Agric. Sci.*
- [20] Tharise N, Julianti E and Nurminah M Evaluation of physicochemical and functional properties of composite flour from cassava, rice, potato, soybean and xanthan gum as alternative of wheat flour *Int. Food Research J.* **21** (4) 1641-49
- [21] Jane J, Chen YY, Lee LF, McPherson AE, Wong KS, Radosavljevic M and Kasemsuwan T 1999 Effects of amylopectin branch chain length and amylose content on the gelatinization and pasting properties of starch *Cereal Chem.* **76** (5) 629-37
- [22] Bhattacharya M, Zee Sy and Corke H 1999 Physicochemical properties related to quality of rice noodles *Cereal Chem.* **76** (6) 861-67