Development of Functional Sausage Based on Corn Starch and Moringa Flour with TheAddition of Mocaf (*Modified Cassava Flour*) and Porang Flour

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Abstract. This study aims to determine the best formulation of corn starch: moringa flour with the addition of mocaf and porang flour to produce the best quality sausage. The method used was an experimental method carried out in the laboratory using a Completely Randomized Design (CRD) with one factor, namely the concentration of corn starch and moringa flour which consists of 6 treatments. The treatments included the concentration of corn starch: moringa flour, namely P0 (75%:0%), P1 (72%:3%), P2 (69%:6 %), P3 (66%:9%), P4 (63%:12%), P5 (60%:15%). The sausage quality parameters tested were chemical quality (contents of calcium oxalate, moisture, ash, protein, and crude fiber), physical quality (test color, texture) and organoleptic quality (color, aroma, elasticity, and taste). Observational data were tested by analysis of variance at 5% level using Co-Stat software and futher tested using the Honestly Significant Difference (HSD) test. The results showed that P1 was the best treatmet which produces 62.59% moisture content; ash 1.00%; 2.09% protein; crude fiber 11,35%; ^{o}Hue 88,52^{o} (green); texture 1.73 N/mm^2; slightly unpleasant smell; slightly chewy; and taste is not bitter; and the hedonic response was somewhat favored by the panelists.

Keywords: Analog Sausage, Corn Starch, Mocaf, Moringa Flour, Porang Flour.

1 Introduction

Recently, people begin to consume fast food and processed products from livestock products, one of the products is best known and consumed by most people sausage. Sausage is a food product made from meat or a mixture of several types of chopped meat or ground meat which is seasoned and then put into a casing or sausage container [1]. The consumption of sausage in Indonesia is growing 4.46% each year. High demand for sausages also causes an increase in the demand for meat production. Chairman of the IndonesianMeat Processing Industry Association (NationalMeat Processor Association-NAMPA) said that the need of beef for each industry is 1,500 tons per month and almost 100% meat for theindustry is imported from several countries due tolimited availability in the domestic market andrelatively expensive prices [2].

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One of the efforts to reducing meat consumption is look for other ingredients that can replace the use of meat, which is making sausages from starch. Using corn starch will improve thetextural properties of food and can increase the nutritional value. Analogues sausages have several advantages compared to general sausages, including the protein content that is beneficial to the health of body [4]. However, corn starch as the main ingredient does not contain much protein as protein in meat, so it is necessary to add other ingredients as a source of nutrition, especially protein.

One of the vegetable ingredients that has a protein source which commonly used in making analogue sausages is moringa. Moringa flour 100 g has a nutritional content such as 28.70% protein [5]. The addition of 15% moringa leaf flour to tempeh sausages produces tempeh sausages with the highest protein 18.8% [6]. The addition of 15% moringa flour produces shirataki noodles with the highest protein content 4.87% [7].

Sausages generally consist of 75% meat as an ingredient main and 25% filler and binder [8]. Sausages sold in the market generally use a filler in the form of tapioca. Tapioca has a chemical composition of 12% water content; 0.31% fat, 1.19% protein, 81.75% carbohydrates, and 3.34% crude fiber [9]. Ordinary cassava flour still has a strong cassava aroma that can interfere with the quality of the product [10]. Therefore, flour with better characteristics is needed to replace tapioca flour, one of which is mocaf.

Mocaf is a flour commodity derived from cassava which is modified by microbial fermentation techniques. Mocaf has some qualityis better than Tapioca flour is whiter in color and has a neutral aroma [11]. Mocaf have a protein content close to tapioca and starch content which is higher at 1.2% and 87.3% respectively [12] Tapioca contains protein and starch around 1.19% and 81.75% [9]. The binder usually used in sausage products on the market is a binder in the form of sodium tripolyphosphate (STPP), which is a type of artificial food additive. As it is known, the use of synthetic chemicals continuously can cause effects that are not good for health. Therefore, we need a material that can replace the function of the sodium tripolyphosphate. One food ingredient that has a function like STPP is porang tuber flour. Porang flour from porang tubers contains dietary fiber soluble compounds whose structure and function are similar to pectin are also called glucomannans. Glucomannan has the ability as gelling agents which is able to replace the STPP function found in sausages in general [13]. The addition of 3% porang flour as a binder for chicken sausages produces chicken sausages with thebest chemical quality and the addition of 2% porang flour produces chicken sausages that are acceptable to consumers.

The purpose of this study was to determine the best formulation of corn starch and moringa flour with the addition of mocaf and porang flour to produce sausages with the best quality.

2 Materials and Methods

The materials used in this study were BISI-11 hybrid corn (obtained from Janapria, Central Lombok), Moringa leaves (obtained from Janapria, Central Lombok), cassava type Adira I (obtained from Pancor, East Lombok), porang kuning (obtained from

Wajageseng, Kopang), ice water, vegetable oil, BIMO-CF starter, mushroom broth (totole brand), garlic powder (koepoe-koepoe brand), collagen casings, distilled water, boiling chip granules, phenolphthalein (pp), 0.1 N hydrochloric acid (HCL), sulfuric acid (H_2SO_4) 0.25 N, $KMnO_4$ 0.05 M, natrium chloride (NaCl), Na_2SO_4 anhydrous, $CuSO_4$ 0.01M, NaOH 0.313 N, K_2SO_4 10%, and sodium bisulfite 0.2%.

The tools used in this study were blenders (brand phillips), cabinet dryer, mixer (phillips brand),spoon, container, analytical balance (KERN brand),oven, knife, stove (RINNAI brand), spatula, plastic gloves, plastic funnel, porcelain dish, mortar, dropper, 1000 mL measuring cup, erlenmeyer (250mL, 300mL and 500mL), funnel, furnace, distillator (behrotest brand), colorimeter (MSEZ) fruit hardness analyzer, filter paper, thermocouple, and sieves (80-mesh and 100-mesh).

2.1 Methods

The research method used was an experimental method with a completely randomized design (CRD) single factor, namely the concentration of corn starch and moringa flour with 6 treatments, which consists of P0 (75%:0%), P1 (72%:3%), P2 (69%:6%), P3(66%:9%), P4 (63%:12%), P5 (60%:15%) by setting the concentration of 22% mocaf and 3% porang flour.

Observational data were analyzed by analysis of variance (ANOVA) at 5% significance level. If there is a significant difference in the results of the analysis, then a further test will be carried out with the honest significant difference test (BNJ) at the 5% level. The parameters that observed included calcium oxalate content [14], water content [15], ash content [16], protein content [16], crude fiber content [16], color [17], texture [18], organoleptic [19].

2.2 Research Implementation

Corn Starch Making. Procedure for making corn starch refers to [20]. Corn that has been sorted are dried in the sun at a temperatureof around 50°C for 2 hours and then broken down to produce corn rice. Corn rice is dried using cabinet dryer with a temperature of 55°C for 12 hours then milled becomes flour corn. Flour corn soaked with 0.1% NaOH solution for 3 hours at room temperature until it settles. The precipitated starch is then separated and washed clean so that it can be dried using cabinet dryer at 50°C for 2 hours. The dried starch was then ground and sieved through an 80-mesh sieve.

Moringa Flour Making. The procedure for making Moringa flour refers to [21]. Moringa that has been sorted and washed will then be blanched at a temperature of 80°C for 30seconds which aims to inactivate the enzyme.Moringa dried in cabinet dryer at 50°C for 1.5 hours so that it can be ground and sieved using an 80-mesh sieve.

Mocaf Making. Procedure of Mocaf on this study refers to [22]. Clean cassava that has been peeled and washed and then sliced into chips with a thickness of 0.2-0.3 cm. The cassava chips were then fermented using 1% BIMO-CF starter for 12 hours at room temperature and then drained. The fermented cassava chips are then dried in an oven at 50°Cfor 24 hours so that it can be ground and sieved using a 100-mesh sieve.

Porang Flour Making. Procedure for making porang flour refers to [23]. Clean porang will besliced into chips with a thickness of 0.2-0.3 cm. Porang chips are then soaked in 15% NaCl solution for 6 hours to reduce calcium oxalate and then drained. The porang chips were then boiled again using 8% NaCl and washed thoroughly.Porang chips are soaked on 0.2% sodium bisulfate solution for 10 minutes to increase the whiteness degree then the porang chips were washed clean. Porang chips are dried using cabinet dryer with temperature 60°C for 6 hours then grounded and sieved through a 100-mesh sieve.

Sausage Making. The procedure for making sausages in this study refers to [24]. All ingredients such as corn starch, moringa flour, mocaf, porang flour, spices and ice water were mixed by mixers for 2 minutes. After that added oil vegetable until blended. The dough is then put into the sleeve and tied to form a sausage. The tied sausages are then soaked in warm water at 60°C for 10 minutes. The sausages are then cooked by boiling at 85°C for 30 minutes.

3 Results and Discussion

The results of the analysis of water content, ash content, protein content, color, texture andorganoleptic function of functional sausages can be seen in Table 1.

3.1 Calcium Oxalate Level

Calcium oxalate is a compound that contained in many tubers, one of them is porang tuber. The presence of calcium oxalate in porang tubers is an obstacle because of the itching sensation when consumed without pre- treatment. Determination of calcium oxalate levels using the permanganometric method [14]. Based on the results of the analysis, the level of calcium oxalate found in the porang flour used in this study was 0.59% or around 0.59 g/100g. The maximum safety standard for consuming calcium oxalate for each person is 2 g/day [25]. The limit for consumption or safe levels of calcium oxalate for the body is not more than 1.25 g/day [26]. Based on the analysis of calcium oxalate, it can be stated that the porang flour produced is still suitable for consumption.

3.2 Moisture Content

Based on the ANOVA result for the effectof the formulation of corn starch and moringa flour on the water content of sausages obtained significantly different results (significant). The water content of the sausages obtained ranged from 59.30% (P5) - 65.93%

(P0). The water content of the sausages in all the resulting treatments is known to meet the quality requirements for the water content of the sausages mentioned in SNI 01-3820-2015 which is a maximum of 67% [8].

The decrease in the water content of sausages was in line with the decrease in the concentration of corn starch and the increase in Moringa flour (see Tab.1). This is due to the moisture content of the materials used. Corn starch has a higher water content than Moringa flour. The moisture content of corn starch in this study was 13.74% while Moringa flour was 11.38%. High water absorption capacity is related to the ratio of amylose and amylopectin levels in flour [27]. The lower the amylose compared to the amylopectin, the higher the absorption capacity, thus the water content will increase. Corn starch itself has a lower amylose content ratio than amylopectin, namely 15-30% amylose and 70-85% amylopectin. Meanwhile, it contains very little starch due to its high protein and fiber content [28]. Therefore, the lower the concentration of corn starch used, the water content of the sausage will decrease more.

Based on the results of the further HSD test, it was known that the P1 to P4 treatments had no significant effect on reducing the water content of sausages. This could be due to the fact that the amount of addition of Moringa flour was the same as the amount of corn starch that was reduced, so that the water content produced tended to be not significantly different. The water content which was not significantly different was also due to the fact that the protein content in thi study was not significantly different from the addition of Moringa from P1 to P4. Protein in Moringa should be able to bind water molecules through hydrogen bonds due to the presence of functional groups, causing the water content of the material to decrease [29]. The results of this study are in accordance with [7] study, where the higher the addition of moringa flour to shirataki noodles, the moisture content of shirataki noodles decreases. The more addition of Moringa flour to the cookies, the moisture level will be lower [30].

3.3 Ash content

Based on the ANOVA result for the effect of corn starch and moringa flour formulationson the ash content of sausages, the resultswere not significantly different (non-significant).The results obtained ranged from 0.71% (P0) –1.53% (P3). The ash content of sausages in all treatments produced is known to meet the quality requirements of sausage ash contentmentioned in SNI 01-3820-2015 which states that the ash content for combined meat sausages is a maximum of 3% [8].

The formulation of Corn starch and Moringa flour has no significant effect on the ash content of the sausages obtained (see Tab. 1). This is thought to be due to the fact that apart from moringa flour, otherflour ingredients still contain minerals. The mineral content of corn starch in 100 g is 0.4% [31], moringa flour is 7.85% [32], mocaf is 0.30% [12] and porang flour is 3.01% [33]. Moringa flour does have the highest mineral content, but the concentration added is not greater than the concentration of corn starch. This is in line with [34] that the addition of moringa flour did not have a significant effect on the ash content of the donuts. [35] also shows that addition of moringa flour has no significant effect on the ash content of chicken meatballs.

Table 1. Data on results of analysis of the chemical, physical and organoleptic quality of functional sausages

Parameters	Treatment					
	P0	P1	P2	P3	P4	P5
1. Chemical Quality						
Moisture content (%)	65,93^{a}	62,59^{b}	62,53^{bc}	62,08^{bc}	61,96^{bc}	59,30
Ash content (%)	0,71	1,00	1,28	1,53	1,14	1,27
Protein content (%)	1,03^{b}	2,09^{ab}	2,75^{ab}	3,11^{ab}	3,43^{a}	3,77^{a}
Crude fiber content (%)	7,74^{b}	11,35^{ab}	12,02^{ab}	13,46^{ab}	13,75^{ab}	14,36
2. Physical Quality						
Color (°Hue)	80,78^{a}	88,52^{c}	87,65^{c}	84,70^{b}	85,13^{b}	86,79^{l}
Texture (N/mm^{2})	1,15^{c}	1,73^{b}	1,95^{ab}	2,05^{ab}	2,18^{ab}	2,28^{a}
3. Organoleptic Quality						
(Hedonic Quality)						
Color	3,15^{a}	1,9^{c}	3,05^{a}	2,25^{bc}	2,8^{ab}	2,2^{bc}
Aroma	3^{a}	2,85^{ab}	2,7^{abc}	2,15^{bcd}	2,1^{cd}	1,85^{d}
Elasticity	3	2,55	2,75	2,7	2,7	2,75
Flavor	3,4^{a}	3,04^{ab}	2,4^{bc}	2,25^{c}	1,95^{c}	1,95^{c}
(Scoring Quality)						
Aroma	2,6^{b}	2,65^{b}	3,2^{ab}	3,45^{ab}	3,75^{a}	3,39^{a}
Elasticity	3,25	2,7	3,25	2,95	3,05	2,95
Flavor	2,4	2,5	2,85	3,15	3,15	3,25

Note: Numbers followed by different lowercase letters are significantly different according to the HSD test at the level of 5%

Hedonic score: 1 = very dislike; 2 = dislike; 3 = quite like; 4 = like; 5 = very like

Scoring score:

Aroma: 1 = very odorless; 2 = not unpleasant; 3 = slightly smells bad; 4 = smells bad; 5 = very unpleasant

Tenderness: 1 = very not chewy; 2 = not chewy; 3 = slightly chewy; 4 = chewy; 5 = very chewy

Taste: 1 = very not bitter; 2 = not bitter; 3 = slightly bitter taste; 4 = bitter; 5 = very bitter

3.4 Protein Content

The protein content of the sausages obtained ranged from 1.03% (P0) – 3.77% (P5). Sausage protein content in all treatments produced is known to have not met the quality requirements for sausage protein content mentioned in [8] which states that the protein content for sausages meat combination minimum 8%. This happens because almost 100% of the ingredients in this manufacture are vegetable and without meat addition.

The protein content of sausages increased along with the increasing concentration of moringa flour (see Tab. 1). This is because moringa flour has a high protein content, which in this study has a protein content of 27.82%, while corn starch according to [36] has a low protein content of 0.56%. Therefore, the higher the concentration of moringa flour added, the protein content in the sausage will also increase. This is in accordance with [7], that the higher the concentration of moringa flour that is added causes the protein content of shirataki noodles to increase, which with the addition of 15% moringa produced shirataki noodles with the highest protein content (4.87%).

3.5 Crude Fiber Content

The effect of corn starch and moringa flour formulations on the crude fiber content of sausages were significantly different (see Tab. 1). The crude fiber content of the sausages obtained ranged from 7.74% (P0) – 14.36% (P5). The fiber content of sausage increases with the increasing concentration of moringa flour. This is because moringa flour has a fairly high crude fiber content, which is around 12.63% [37], while corn starch does not contain fiber [36]. The high crude fiber content in sausage products also comes from the binder used, namely porang flour. Porang flour contains about 11.79% fiber [35].

The crude fiber content of sausages in treatment P0 was not significantly different fromtreatments P1 to P4, but significantly different from treatment P5. There was also no significantdifference in the treatment of P1 to P5. This is thought to occur because the crude fiber content in Moringa has changed due to the boiling process at a fairly high temperature. Boiling can cause low levels of crude fiber due to Fiber components such as hemicellulose of the material can be dissolved in warm or hot water [38]. Therefore, increasing the concentration of Moringa causes an increase in fiber content in sausages which is not significantly different.

3.6 Color

The effect of the formulation of corn starch and moringa flour on the color value °Hue sausage was significantly different (see Tab. 1). Score °Hue of the sausages produced in this study were interpreted on Munsell's imaginary balls, so the color of the sausages before the addition of Moringa (P0) was 80.78° (Quadrant I) with yellow-red and after the addition of moringa average green. Value °Hue of 53 (Quadrant I) – 84 (Quadrant I) has a red-yellow color and the value °Hue of 62 (Quadrant II) – 0 (Quadrant III) has a green color [17]. This shows that the higher the addition of Moringa flour, the color of the sausage becomes green and without the addition of Moringa flour, the color of the sausage becomes yellow and close to red. This is due to the color of the raw material. Moringa flour is green and corn starch is yellowish white. The green color of Moringa flour comes from chlorophyll or green pigments found in plants [37].

Table 2. Mean Value of L* Functional Sausage

Treatment (% Corn Starch:% Moringa Flour)	L* Score Means
P0 (75:0)	57,62
P1 (72:3)	50,81
P2 (69:6)	31,79
P3 (66:9)	31,66
P4 (63:12)	29,03
P6 (60:15)	28,8

The L* value of sausage tends to decrease with increasing concentration of Moringa flour (see Tab. 2). This is due to the differences in the color of the raw materials used, where moringa flour have color which darker compared to corn starch. Therefore, when the concentration of moringa flour is increased, the color of the sausage product will be darker.

3.7 Texture

The effect of the formulation of corn starch and moringa flour on sausage texture was significantly different (see Tab. 1). The obtained sausage texture ranged from 1.15 N/mm^2 (P0) - 2.28 N/mm^2 (P5). The texture (hardness level) of the sausages increased with increasing moringa flour concentration and decreasing corn starch. This is thought to be caused by the high content of crude fiber in Moringa flour, which causes low water absorption. The increase of the hardness of sausages is also in line with increasing fiber content and decreasing water content. The fiber content in a material can affect the texture of the product because fiber can affect water absorption [39]. Crude fiber content can cause a decrease in water absorption in starch granules. Therefore, the low water absorption due to the high crude fiber can cause an increase in the texture (level of hardness) in sausages.

3.8 Organoleptic Color

The effect of the formulation of corn starch and moringa flour on the hedonic organoleptic color of sausages was significantly different. The results of the hedonic analysis of sausage color ranged from 1.9 to 3.15 with the criteria of not liking to quite liking. Treatments P0 and P3 got the highest hedonic values, namely 3.15 and 3.05 (quite favored) while P1 got the lowest hedonic values, namely 1.9 (disliked).

3.9 Organoleptic Aroma

The effect of corn starch and moringa flour formulations on the hedonic and organoleptic aroma of sausages were significantly different (see Tab. 1). The results of the hedonic analysis of sausage aroma ranging from 1.85-3.00 (with the criteria of not liking it to quite liking it), while the average scoring score ranges from 2.60 - 3.95 (rather unpleasant to smelly).

Based on the results of hedonic analysis and scoring, it can be seen that the higher the concentration of Moringa added, the level of musty aroma of the sausage produced will increase and the level of preference of the panelists will decrease. This is because the Moringa flour used still has a distinctive unpleasant aroma which is not liked by the panelists. This is in accordance with [29], where the preference of panelists in terms of aroma tends to decrease along with increase in the concentration of Moringa flour due to the unpleasant aroma of the more dominant moringa.

3.10 Organoleptic Elasticity

The effect of the formulation of corn starch and moringa flour on the hedonic and scoring organoleptic elasticity of sausages were not significantly different (see Tab. 1). The results of the hedonic analysis of sausage elasticity ranging from 2.55-3.00 (with the criteria of quite liking), while the average scoring assessment ranges from 2.70-3.25 (slightly chewy). The elasticity was caused by the water content in the material, where the results of the analysis of the water content with the addition of Moringa with treatments P1 to P4 were not significantly different, so that the elasticity of sausages was also not significant.

3.11 Organoleptic Taste

The effect of the formulation of corn starch and moringa flour on the hedonic and scoring organoleptic taste of sausage were significantly different (see Tab. 1). The results of the hedonic analysis of sausage flavors ranging from 1.95 (dislike) - 3,40 (sufficiently like), where the preference of the panelists decreased as the concentration of Moringa flour increased. This is in accordance with [40] that the more addition of Moringa flour, the panelists' preference for noodles decreases because of the bitter taste of Moringa.

Analysis of sausage taste scoring ranged from 2.40 (not bitter) - 3.25 (slightly bitter). This value shows that treatment P0 (75% corn starch and 0% moringa flour) did not taste bitter, while treatment P1 to P5 all tasted slightly bitter. This insignificant bitter taste can be caused by the addition of other ingredients such as spices. The resulting product still has a slightly bitter taste due to the natural content of the moringa itself. The distinctive taste of Moringa leaves comes from several secondary metabolite components in it such as saponins, tannins and phytic acid [41]. Saponin compounds cause a bitter taste and affect the level of consumer acceptance of processed products that are added to moringa. The distinctive taste of Moringa is still difficult to remove.

4 Conclusion

The treatment of corn starch and moringa flour formulations gave significantly different results on water content, protein content, crude fiber content, texture, color (physical), color (hedonic), aroma (hedonic and scoring) and taste (hedonic), but not different. significantly on ash content, elasticity (hedonic and scoring) and taste (scoring). The higher the addition of Moringa flour and the less addition of corn starch in the manufacture of sausages can increase the protein content, ash content, crude fiber content, and texture (hardness).

References

1. Purwosari, A.G.: Pengaruh Penggunaan Jenis dan Jumlah Bahan Pengisi Terhadap Hasil Jadi Sosis Ikan Gabus (*Channa sriata*). Jurnal Boga (4)1, 221-223 (2016).

2. Yanuar, R., Dinnata, W.: Anggota NAMPA Nikmati Kenaikan Omzet hingga 30% [online]. https://ekonomi.bisnis.com/read/20170606/99/660015/anggota-nampa-nikmati-kenaikan-omzet-hingga-30. (2017).
3. Irmayana, H., Mardesci, Ninsix, R.: Formulasi Pati Jagung (*Zea mays* L.) dengan Tepung Tapioka terhadap Sifat Fisikokimia Bakso Ikan Gabus (*Ophiocephalus striatus*). Jurnal Teknologi Pertanian 5(2), 47-48 (2016).
4. Nurnaningsih, R.F., Wijaya, M.: Formulasi Sosis Analog Sumber Protein Berbasis Bekatul dan Jamur Tiram Sebagai Pangan Fungsional. Jurnal Pendidikan Teknologi Pertanian 7(1), 43-52 (2021).
5. Indriasari, Y., Basrin, F., Berlian, M.: Pengaruh Proses Blanching dan Ekstraksi Terhadap Nutrisi dan Organoleptik Tepung Daun Kelor (*Moringa oleifera*) Sebagai Pangan Fungsional. Laporan Akhir Penelitian Dosen Pemula Kemenrisetdikti, Politeknik Palu (2018).
6. Rahmayanti, E. A., Wahyu, N.F., Ni'mal, B.: Kadar Protein, Zat Besi dan Uji Kesukaan Sosis Tempe dengan Penambahan Tepung Daun Kelor (*Moringa oleifera*). Jurnal Ilmu Gizi Indonesia 4(1), 29-38 (2020).
7. Utami, D.R.: Pengaruh Penambahan Tepung Daun Kelor (*Moringa oleifera*) Terhadap Mutu Mie Shirataki [skripsi]. Universitas Mataram, Mataram (2021).
8. Badan Standarisasi Nasional: SNI 01-3820-2015 – Sosis Daging Kombinasi. Badan Standarisasi Nasional, Jakarta (2015).
9. Suismono: Hasil-hasil Penelitian Pengembangan Industri Pengolahan Ubi-Ubian (Ubi Kayu dan Ubi Jalar) dengan Teknologi Pedesaan. Bandar Lampung (2003).
10. Murtiningsih, Suyati: Membuat Tepung Umbi dan Variasi Olahannya.PT. Agromedia Pustaka, Jakarta Selatan (2011).
11. Hamidi, M.A., Banowati, E.: Utilization of mocaf flour (modified cassava flour) for revitalization of the use tapioca flour in communities for empowering hulu-hilir human resources in Wonogiri Regency. IOP Conf. Series: Earth and Environmental Science 243, 1-5 (2018).
12. Salim, E.: Mengolah Singkong Menjadi Tepung Mocaf Bisnis Produk Pengganti Terigu. Andi Publisher, Daerah Istimewa Yogyakarta (2011).
13. Anggraeni, D.A., Widjanarko, S.B., Ningtyas, D.W.: Proporsi Tepung Porang (*Amorphophallus muelleri* Blume) : Tepung Maizena Terhadap Karakteristik Sosis Ayam. Jurnal Pangan dan Agroindustri 2(3), 214-223 (2014).
14. Utaminingsih, D. S., Muhtadi.: Analisis Kadar Glukomanan dan Asam Oksalat Beserta Uji Aktivitas Antioksidan dan Antibakteri dari Ekstrak Etanol Umbi Iles-iles (*Amorphopalus oncophylus*). In: The 13th University Research Colloqium, pp. 593-603. Sekolah Tinggi Ilmu Kesehatan Muhammadiyah, Klaten (2021).
15. Purnama F. A., Dewi, L., Hastuti, S. P.: Kadar Air, Abu, Protein dan Karbohidrat pada Tahapan Pembuatan Tempe, pp. 1-9.
16. Sudarmadji, S., Haryono, Suhardi: Analisa Bahan Makanan dan Pertanian. Liberty, Yogyakarta (2007).
17. Hutchings, J. B.: Food Color and Appearance. Aspen Publisher Inc Gaithersburg, Maryland (1999).
18. Suartini, N.L.D.A,: Formulasi Tepung Talas (*Colocasia esculenta* L. Schoot) dan Tepung Kelor (*Moringa oleifera*) Terhadap Nilai Gizi dan Organoleptik Cookies Kacang Merah (*Phaseolus vulganis* L.) (skripsi). Universitas Mataram, Mataram (2019).
19. Rahayu, W.P.: Penuntun Praktikum Penelitian Organoleptik. Jurusan Teknologi Pangan dan Gizi Fakultas Teknologi Pertanian, Bogor (1998).

20. Maflahah, I.: Analisis Proses Pembuatan Pati Jagung (Maizena) Berbasis Neraca Massa. Embryo 7(1), 40-44 (2010).
21. Saloko, S., Sulastri, Y., Alamsyah, A.: Sifat Fisikokimia dan Sensoris Beras Analog Fungsional Tersuplementasi Daun Kelor dan Rumput Laut *Sargassum* sp. In: Prosiding Seminar Nasional SAINTEK, Universitas Mataram (2018).
22. Hadistio, A., Fitri, S.: Tepung Mocaf (*Modified Cassava* Flour) untuk Ketahanan Pangan Indonesia. Jurnal Pangan Halal 1(1), 13-17 (2019).
23. Handayani, T., Herlinasari, D., Aziz, Y.S.: Pembuatan dan Uji Mutu Tepung Umbi Porang (*Amorphophallus oncophyllus* Prain) di Kecamatan Ngrayun. Jurnal Farmasi dan Kesehatan 9(1), 13-21 (2020).
24. Hairani, M.: Uji Aktivitas Antioksidan Sosis Analog Tempe dengan Penambahan Tepung Ubi Jalar Ungu terhadap Penurunan Kadar Gula Darah Mencit Diabetes (skripsi). Universitas Mataram, Mataram (2017).
25. Noor, Z.: Senyawa Anti Gizi. Pusat Antar Universitas Pangan dan Gizi UGM, Yogyakarta (1992).
26. Knudsen, B., Sorborg, I., Trisken, F., Pilegard, K., Risk Assesment and Risk Management of Novel Plant Foods: Concepts and Principles. Food and Chemical Toxicology 46(5), 1681-1705 (2008).
27. Suarni: Prospek Pemanfaatan Tepung Jagung untuk Kue Kering. Jurnal Listbang Pertanian 28(2), 63-71 (2009).
28. Yuniarsih, E., Adawiyah, D.R., Syamsir, E.: Karakter Tepung Komposit Talas Beneng dan Daun Kelor Pada Kukis. Jurnal Mutu Pangan 6(1), 46-51 (2019).
29. Zakaria, Suarni, R.: Optimasi Pembuatan Mie Basah dengan Penambahan Tepung Daun Kelor (*Moringa oleifera*). Jurnal Media Gizi Pangan 24 (1), 28-33 (2017).
30. Erniyati, Ansharullah, Sadimantara, M.S.: Daya Terima dan Analisis Kandungan Gizi Cookies Berbasis Tepung Daun Kelor (*Moringa oleifera* L.) dan Tepung Kacang Merah (*Phaseolus vulgaris* L.). Jurnal Sains dan Teknologi Pangan 4(3), 2204-2219 (2019).
31. Januarti: Optimasi Proses Pengolahan Mie Jagung Instan Berdasarkan Kajian Preferensi Konsumen (skripsi). IPB University, Bogor (2003).
32. Pangaribuan, Dewi, A.: Substitusi Tepung Talas Belitung Pada Pembuatan Biskuit Kelor (*Moringa oleifera* Lamk). Universitas Atma Jaya, Yogyakarta (2013).
33. Mulyono, E.: Peningkatan Mutu Tepung Iles-Iles (Amorphophallus oncophyllus) sebagai Bahan Pengelastis Mie dan Pengental melalui Kg umbi/hari. Laporan Akhir Penelitian Balai Besar Penelitian dan Pengembangan Pascapanen Pertanian, Bogor (2010).
34. Yanti, S., Prisla, E., Mikhatunnisa, M.: Pengaruh Penambahan Tepung Daun Kelor (*Moringa oleifera*) terhadap Karakteristik Organoleptik Produk Donat. Food and Agroindusty Journal 1(1), 1-9 (2020).
35. Fiani, S. D.: Pengaruh Penambahan Tepung Daun Kelor (*Moringa oleifera*) terhadap Mutu Organoleptik, Kadar Serat, Kadar Abu dan Tekstur Bakso Ayam [skripsi] Universitas Brawijaya, Malang (2018).
36. Juniawati: Optimasi Proses Pengolahan Mie Jagung Instan Berdasarkan Kajian Preferensi Konsumen [skripsi]. IPB University, Bogor (2003).
37. Krisnadi, A.D.: Kelor Super Nutrisi. Pusat Informasi dan Pengembangan Tanaman Kelor Indonesia, Blora (2015).
38. Agustin, A.T., Zaini, M.A., Handito, D.: Pengaruh Metode dan Suhu Blanching terhadap Persenyawaan Serat Batang Pisang Sebagai Bahan Baku Pembuatan Ares. Jurnal Ilmu dan Teknologi Pangan 6(1), 609-615 (2020).
39. Sabir, N.C.: Analisis Karakteristik Crackers Hasil Substitusi Tepung Terigu dengan Tepung Ampas Tahu. Jurnal Pendidikan Teknologi Pertanian 6(1), 51-64 (2020).

40. Nur, A., Uliyah, U., Amaliyah, N.F., Hasrawati, A.: Aktivitas Antioksidan Ekstrak Daun Kelor (*Moringa oleifera* L.) dan Pengembangannya Menjadi Bentuk Sediaan Gel. As-Syifaa Jurnal Farmasi 13(1), 1-6 (2021).
41. Shuntang, G.: Current Topics in Saponins and the Bitter Taste. Research in Medical & Engineering Science 5(1), 390-391 (2018).