

Research Article

Physical, Chemical, and Organoleptic Characteristics of Udon Substituted with Kimpul Tuber Flour in Various Treatments: Flour Concentration and Resting Time

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Abstract

Udon is kind a type of Japanese noodle made from wheat protein with a larger size and chewier texture characteristic than basic noodle. Optimizing local agricultural commodities by utilizing kimpul tubers as a substitute is an effort to reduce wheat import activities. Udon has spesifically characteristics that need to be is chewiness. Resting time is needed in udon making, so that water is absorbed into the dough and binds the dough maximally so that the udon is more elastic. The study was conducted to determine the characteristics of udon produced from variations in flour concentration and resting time treatment. This study used a completely randomized design (CRD) with two factors, the first factor was the concentration of kimpul and wheat flour 0%:100% (K1), 15%:85% (K2), and 30%:70% (K3). The second factor was the variation of resting time of 0 minutes (T1), 60 minutes (T2), and 120 minutes (T3). The results showed that udon had the following physical properties: elongation with values ranging from 18.29%-31.11%; tensile strength ranging from 0.47N/m²-2.77N/m²; cooking loss ranging from 0.63%-1.21%; rehydration ranging from 52.33%-69.33%; solubility ranging from 0.77%-1.04%; swelling power ranging from 3.146g/g-3.717g/g; brightness level 46.3-70.3. Than the chemical properties were moisture content ranged from 30.56%-36.90%; ash content ranged from 0.16%-1.61%; protein content ranged from 9.12%-13.86%; starch content ranged from 48.08%-52.49%; amylose content ranged from 11.53%-13.46%; amylopectin content ranged from 34.64%-40.92%. Udon has the highest color organoleptic value of 6.17 (like), taste value of 5.47 (like) texture value of 5.5 (like).

Keywords

Udon, Wheat, Kimpul Flour, Resting Time

1. Introduction

Udon is a type of noodle originating from Japan with characteristics of bright beige color, chewier texture and larger size having a width of 2-3.9 mm with a thickness of 2.5 mm [12, 18, 35]. Udon is made from wheat protein, water, and salt. The increase in udon consumption goes hand in hand with the increase in wheat consumption. Wheat imports in Indonesia

reached 10.3 million tons [16]. If this phenomenon continues, it will have an impact on reducing the country's foreign exchange. So it is necessary to make efforts to reduce wheat consumption and optimize local food, one of which is by making kimpul tubers as a substitute for wheat in making food prod-

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ucts. Kimpul tubers contain 70.73% carbohydrates with amylopectin content of 54.74% and amylose only around 26.92% [20, 26, 31]. Kimpul tuber flour has functional characteristics including *solubility* of 0.58%, *swelling power* of 2.48%. [20]. Meanwhile, wheat flour has functional characteristics of *solubility* 0.21%, and *swelling power* 4.54%. [30, 34].

Kimpul flour contains high levels of carbohydrates, making it an ideal raw material for making udon. However, kimpul tuber flour does not contain gluten, which plays a role in the formation of elastic properties like wheat flour, so research needs to be carried out regarding the right proportion of kimpul flour: wheat flour. The use of protein flour aims to produce udon with a chewy texture and bright color [35]. Udon has characteristics that need to be considered, namely chewiness and elasticity. The use of kimpul tuber flour reduces gluten content so that the elasticity of udon is reduced. Therefore, it is necessary to *rest the dough*. The resting time aims to maximize the hydration of water in the dough and gluten in the dough can form a wider and uniform network to produce elastic udon. This study aims to determine the characteristics of udon produced from variations in flour concentration treatment, and udon resting time.

2. Research Methods

2.1. Materials and Tools

The ingredients for making kimpul tuber udon are kimpul tubers purchased at the Tanjung market, Kaliwates, Jember, East Java. Twin cakra brand commercial flour, water, farmer's brand salt. Materials for analysis are NaOH P.A. emsure, H₂SO₄ concentrated P.A. emsure, ethanol P.A. emsure, 96% ethanol technical emprove, HCl 25% P.A. smartlab, Iodine S.A. emsure, KI P.A. emsure, D-Glucose P.A. merck, Na₂CO₃ P.A. emsure, NaHCO₃ P.A. emsure, Na₂SO₄ P.A. emsure, Na-K-Tatrat P.A. emsure, CuSO₄ P.A. emsure, AM-Molybdat P.A. merck, Na₂HSO₄ P.A. emsure, Diethyl ether P.A. emsure, Boric Acid P.A. smartlab, Selenium P.A. merck, indicator (mixture of 2 parts methyl red 0.2% in alcohol and 1 part methyl blue 0.2% in alcohol) P.A. merck, distilled water.

The tools used are CR-minolta *color reader*, UTM shi-madzu, vortex ika genius 3, water bath, hermle centrifugator, memmert oven, ohaus scales, desiccator, 50 ml buchi kjeldahl flask, distiller, magnetic stirrer ika c-mag hs 7, genesys 10 s uv-vis spectrophotometer, lenovo laptop.

2.2. Research Methods

This study used a 2-factor completely randomized design (CRD), namely the concentration of kimpul tuber flour and wheat flour 0%: 100% (K1), 15%: 85% (K2), and 30%: 70% (K3). The second factor is the variation of resting time for 0 minutes (T1), 60 minutes (T2), and 120 minutes (T3). The study consisted of 9 samples with three repetitions of each sample. The data obtained were analyzed using the two-way

ANOVA (*Analysis of Variance*) method with the SPSS 26 application. The significantly different analysis results will be further tested using the DMRT (*Duncan Multiple Range Test*) test at the 5% level. Organoleptic test data were processed using Microsoft Excel software.

2.3. Research Implementation

2.3.1. Process of Making Kimpul Tuber Flour

The process of making kimpul tuber flour starts from the process of peeling kimpul tubers and then washing them using 500 ml of clean water, this aims to remove dirt attached to the kimpul tubers. The clean kimpul tubers are then sliced into chips with a thickness of 1 cm, then the chips are soaked in 400 ml of 10% w/w NaCl solution for 60 minutes. This process aims to eliminate oxalate content in kimpul tubers. The soaked chips were then washed with 500 ml water to remove the remaining NaCl. The chips were then dried using an oven at 60° C for 24 hours. The dried chips are then crushed using a blender to become coarse kimpul tuber flour. The coarse kimpul tuber flour is then sieved using a 100 mesh sieve. The flour that passes this sieve will be used as raw material for making udon [37].

2.3.2. Process of Making Udon Substituted with Kimpul Tuber Flour

The process of making udon from flour with kimpul tuber flour substitution begins with the process of mixing kimpul tuber flour and flour according to the treatment variation with a total amount of 100 grams with the addition of 34 ml of water and 1 gram of salt that has been dissolved so that it becomes udon dough. The udon dough was then rested for 0, 60, and 120 minutes at room temperature. The rested and risen dough is flattened using a rolling pin to form sheets with a thickness of approximately 3 mm and then cut using a knife to form udon like ropes. The raw udon was then boiled for 30 minutes to produce cooked udon which was then analyzed.

2.4. Observation

2.4.1. Elongation and Tensile Strenght

Elongation and tensile strength testing using Lloyd Instrument's Universal Testing Machine (UTM). Measurement begins with pressing the "power" button on the tool. Then the sample is placed on the sample clamp tool, namely at the top and bottom. The sample is locked by turning the lever part of the handwheeel. The working principle of the Universal Testing Machine (UTM) is that the clamp will exert a force in the form of a pull on the sample until it breaks [2].

2.4.2. Cooking Loss and Rehydration Power

Cooking loss measurement can be done by weighing 5 grams of raw samples, then weighing an empty 100 ml beaker

glass (a gram) and filled with water and then brought to a boil. The sample is boiled for ± 7 minutes, drained until no water drips anymore, the remaining cooking water is reheated until half of it remains (filtrate). The filtrate was then oven for 24 hours and weighed until constant weight (b grams) [7]. Meanwhile rehydration power was carried out using the weighing method. Rehydration power is the ability of noodles to absorb water after gelatinization. Measurements were calculated by drained raw sample of udon which were boiled before then weighed as b gram [23].

2.4.3. Swelling Power and Solubility

The starch sample was placed in a sealed test tube (known empty weight), added 10 ml of distilled water and vortexed for 10 seconds. Then incubated in a water bath (85 °C; 30 minutes) while occasionally stirring. Then cooled in ice water until it reached room temperature (± 28 °C). The solution was centrifuged at 2000 rpm (30 min). The supernatant liquid was transferred into a weighed cup and then placed in an oven (105 °C) until a constant weight (W1) was obtained. The remaining precipitate in the test tube was weighed (WS) [33].

2.4.4. Lightness

The lightness measurement used Color Reader CR-10 (Konica Minolta Sensing, Inc, Japan). The working principle of the color reader tool is to measure the color difference through the reflection of light by the sample surface. The first step is to turn on the color reader by pressing the power button. The next process is standardization by placing the lens on standard porcelain perpendicularly and pressing the "Target" button then the value will appear on the L screen which is the standardization value. Take readings on the dye sample by pressing the "Target" button again so that the dL value appears [13].

2.4.5. Moisture and Ash Content

The first stage carried out in the analysis of water content is to dry the cup in an oven at 105 °C for 1 hour. The cup was then placed into a desiccator for about 15 minutes and allowed to reach room temperature and then weighed. Samples weighing 3-4 g were weighed using an analytical balance. The cup containing the sample was placed in an oven at 102-105°C for 5-6 hours. The cup was then placed in a desiccator for 30 minutes and allowed to cool, then weighed and repeated the procedure until a constant weight was obtained. Samples that have known moisture content are then ignited using a furnace with a temperature of 550 °C to achieve complete ignition. The cup is placed in a desiccator and left to cool and then weighed until constant [5].

2.4.6. Protein Content

The sample was weighed as much as 0.5 g and then put into a 100 mL Kjeldahl flask, then added a catalyst in the form of 0.9 g of selenium and 5 mL of concentrated H₂SO₄. The sample was deconstructed in an acid chamber until the solution was

clear for 1.5 hours and then cooled for 45 minutes, then distilled. Samples that have been cooled then added 15 ml of 4% boric acid and MMBB indicator as much as 2 drops, then the sample is entered destilator. At the distillation stage, the ammonium sulfate contained in the sample is broken down into ammonia with the addition of 30% NaOH and heated. The distillation results were collected in a 250 mL Erlenmeyer flask containing a mixture of 15 mL of 4% boric acid (H₃BO₃) and 2 drops of pink MMBB indicator. The distillation process is complete when the solution changes color from purple to green. Then the distillate was titrated with 0.02 N HCl until the green color changed to bluish purple. The titrant volume was read and recorded. The blank solution was analyzed as an example [5].

2.4.7. Total Starch Content

The process of analyzing the total starch content is by taking 1 ml of the sample taken and diluted with distilled water to a volume of 10 ml with a 10 ml volumetric flask then the sample is taken as much as 0.25 ml and put in a test tube. The sample was added 1 ml of Nelson solution then heated to boiling for 30 minutes on a *hot plate* and cooled. The sample was then added 1 ml arsenomolybdate solution and shaken using a *vortex*. The sample was then added 7.75 ml of distilled water and shaken until homogeneous. The absorbance of the sample was measured at a wavelength of 540 nm using a spectrophotometer so that the reducing sugar content could be calculated. Determination of total starch content (% wt) was done by multiplying the glucose content by a factor of 0.9 [36].

2.4.8. Amylose Content

A total of 100 mg of sample was added with 1 mL of 96% ethanol and 9 mL of 1 M NaOH into a *beaker glass* and then heated at 95 °C until a gel was formed. After cooling, the gel solution was transferred into a 100 mL quantitative flask and distilled water was added until the mark and homogenized. The sample solution was pipetted 5 mL and then transferred into a 100 mL measuring flask, then added 1 mL of 1 M acetic acid solution and 2 mL of iodine solution, then measured with distilled water. The solution was left for 20 minutes and the absorbance was measured at a wavelength of 625 nm. Determination (%) of amylose content was done using the equation obtained from the amylose standard curve [36].

2.4.9. Amylopectin Content (by Difference)

Amylopectin content is calculated *by difference*, which is the result of reducing the total starch content with amylose content [4].

2.4.10. Organoleptic Includes Texture, Taste, and Colour

Sensory testing was carried out with a favorability test. The liking test was conducted to determine the level of consumer acceptance of the udon produced including texture, taste, and color. The test was conducted by giving 9 udon samples to the

panelists. Previously, the samples were coded randomly to avoid bias. The minimum number of panelists for the favorability test was 30 untrained panelists who were students of the Faculty of Agricultural Technology, University of Jember with a numerical scale of 1 to 7 with the information 1 = Very dislike, 2 = Dislike, 3 = Somewhat dislike, 4 = Neutral, 5 = Somewhat like, 6 = Like, 7 = Very like [1].

3. Results and Discussion

3.1. Physical Characteristics of Udon

The physical characteristics of udon observed included

elongation, tensile strenght, cooking loss, rehydration power, solubility and swelling power and lightness. Based on AN-NOVA test at $\alpha \leq 0.05$ significance level, the variation of kimpul flour concentration treatment significantly influenced all physical characteristics. While *resting* time only significantly affects the physical characteristics of *elongation, tensile strenght, and lightness*. Increasing the use of kimpul flour decreased the value of *elongation, tensile strenght, rehydration power, solubility, swelling power, and lightness*, but increased the value of *cooking loss*. Increasing the *resting* time increased the *elongation and tensile strenght* values but decreased the *lightness* value.

Table 1. Average Values of Udon Physical Characteristics.

Treatment Sample	Observation Parameters						
	Elongation (%)	Tensile Strenght (%)	Cooking Loss (%)	Rehydration Power (%)	Solubility (%)	Swelling Power (g/g)	Lightness
K1T1	29,55 $\pm$ 0,35 ^b	2,01 $\pm$ 0,01 ^c	0,79 $\pm$ 0,06 ^{bc}	67,67 $\pm$ 0,58 ^a	1,02 $\pm$ 0,05 ^a	3,715 $\pm$ 0,001 ^a	70,3 $\pm$ 0,3 ^a
K1T2	30,69 $\pm$ 0,24 ^a	2,34 $\pm$ 0,01 ^b	0,74 $\pm$ 0,10 ^d	68,67 $\pm$ 0,58 ^a	1,03 $\pm$ 0,01 ^a	3,716 $\pm$ 0,001 ^a	70,2 $\pm$ 0,3 ^a
K1T3	31,11 $\pm$ 0,57 ^a	2,77 $\pm$ 0,01 ^a	0,63 $\pm$ 0,22 ^d	69,33 $\pm$ 1,53 ^a	1,04 $\pm$ 0,02 ^a	3,717 $\pm$ 0,001 ^a	65,9 $\pm$ 0,6 ^b
K2T1	24,74 $\pm$ 0,60 ^d	1,37 $\pm$ 0,01 ^f	0,95 $\pm$ 0,18 ^{abcd}	58,67 $\pm$ 0,58 ^b	0,86 $\pm$ 0,03 ^b	3,440 $\pm$ 0,002 ^b	52,0 $\pm$ 0,3 ^c
K2T2	25,13 $\pm$ 0,33 ^d	1,51 $\pm$ 0,01 ^e	0,91 $\pm$ 0,17 ^{abcd}	60,00 $\pm$ 1,00 ^b	0,87 $\pm$ 0,01 ^b	3,441 $\pm$ 0,001 ^b	51,8 $\pm$ 0,4 ^{cd}
K2T3	26,39 $\pm$ 0,63 ^c	1,76 $\pm$ 0,01 ^d	0,85 $\pm$ 0,46 ^{bcd}	60,33 $\pm$ 0,58 ^b	0,88 $\pm$ 0,01 ^b	3,442 $\pm$ 0,001 ^b	51,4 $\pm$ 0,3 ^d
K3T1	18,29 $\pm$ 0,15 ^g	0,47 $\pm$ 0,01 ⁱ	1,21 $\pm$ 0,20 ^a	52,33 $\pm$ 0,58 ^c	0,77 $\pm$ 0,01 ^c	3,146 $\pm$ 0,002 ^c	48,1 $\pm$ 0,8 ^e
K3T2	19,64 $\pm$ 0,57 ^f	0,52 $\pm$ 0,02 ^h	1,16 $\pm$ 0,16 ^{ab}	52,67 $\pm$ 1,53 ^c	0,77 $\pm$ 0,02 ^c	3,147 $\pm$ 0,001 ^c	47,6 $\pm$ 0,2 ^f
K3T3	20,65 $\pm$ 0,17 ^e	0,62 $\pm$ 0,02 ^g	1,11 $\pm$ 0,44 ^{abc}	55,00 $\pm$ 1,00 ^c	0,78 $\pm$ 0,01 ^c	3,148 $\pm$ 0,001 ^c	46,3 $\pm$ 0,4 ^g

Elongation value is influenced by the gluten content of amylose and amylopectin in the ingredients used. Kimpul flour does not contain gluten, so the higher the proportion of kimpul flour used, the lower the gluten content in the udon which results in a decrease in elongation [32]. The higher the soluble amylose content during gelatinization causes an increase in granule swelling so as to increase the elasticity of udon. This is inversely proportional to the higher level of soluble amylopectin which decreases elasticity [22] Increasing *resting* time produces udon with higher elongation. This is because during the *resting* process the gluten network will be bound by new disulfide bonds to form a wider and more uniform gluten network which makes the udon more elastic [42].

Tensile strenght value is influenced by the amount of kimpul flour used. The lower the gluten content in udon, the easier it will break. This is because glutenin and gliadin in gluten proteins play a role in the formation of a tighter and sturdier structure and elastic so that it is resistant to pulling [7, 32].

The higher level of soluble amylose during gelatinization causes an increase in granule swelling so as to increase the elasticity of udon. This is inversely proportional to the higher level of soluble amylopectin which decreases elasticity [22]. The more elastic the udon produced, the higher the force required to break the udon strands. Increasing the *resting* time increases the *tensile strenght*. This is because during the *resting* process the gluten network that has been depolymerized in the kneading process will be bound by new disulfide bonds to form a more uniform gluten network that makes the udon more elastic and not easily broken so that the force required to break the udon is higher [42].

The *cooking loss* value decreases as the amylose and gluten protein content increases. Intermolecular bonds in starch granules play an important role in solids loss during cooking [24]. During the gelatinization process, amylose can form a strong starch gel structure in udon because its linear structure easily forms a three-dimensional network so that the durability of the

molecules in the starch increases [3, 22]. The reduced amount of gluten results in an unstable and uncompact dough so that many particles of ingredients are released during the cooking process [29].

Rehydration power is lower as more kimpul flour is added, the lower the rehydration power. Reducing the proportion of wheat flour as a raw material will reduce the proportion of udon gluten protein. Gluten has the ability to bind and retain water so that water absorption increases [9]. The higher the addition of kimpul flour concentration, the lower the amylose content of udon and the higher the amylopectin content. [11, 20]. Amylose has an amorphous structure composed of straight chains with shorter α -(1,4)-D-glucose bonds so that it is easily hydrated by water, while amylopectin is in a tight crystalline area so that it is more difficult to hydrate by water [39, 41]. In accordance with research before stated that the higher the use of MOCAF flour with lower amylose content than wheat flour resulted in wet noodles with low rehydration power. *Resting* time did not significantly affect the rehydration power of udon made from kimpul tuber flour.

Udon made from a lower proportion of chimp flour and longer resting time had higher solubility and swelling power values. This is because during the heating process gelatinization will occur which causes amylose which is composed of straight chains with α -(1,4)-D-glucose bonds to be released out of the granule and bind to [41]. Furthermore, the double helix structure in amylopectin will stretch and the hydrogen bonds will be broken [14]. The more hydrogen bonds that are

broken and the structure of the starch granule is open, the more water enters the granule which causes swelling [14, 17]. *Resting* time did not significantly affect the *solubility* and *swelling power* values.

The lightness value is influenced by the concentration of kimpul flour and the *resting* time used. This is because kimpul contains saponin compounds which when heated at temperatures $>100^{\circ}\text{C}$ in high-carbohydrate foodstuffs will cause a brown color due to the saponin content [28]. Udon made through 120 minutes resting time has a lower lightness value than 0 minutes resting time. This is related to the increase in macropolymer glutenin content during the resting time [19]. So that it has more potential to cause maillard reactions in the cooking process [7].

3.2. Chemical Characteristics of Udon

The chemical characteristics of udon observed included moisture, ash, protein, total starch, amylose, and amylopectin. Based on ANNOVA test at $\alpha \leq 0.05$ significance level, the variation of kimpul flour concentration treatment significantly influenced all chemical characteristics. While *resting* time only significantly affects the moisture content. Increasing the use of chimpul flour decreased water content, protein, amylose but increased ash content, total starch and amylopectin. Increasing *resting* time significantly increased the water content which can be seen in Table 2.

Table 2. Average Values of Udon Chemical Characteristics.

Treatment Sample	Observation Parameters					
	Water Content (%)	Ash Content (%)	Protein Content (%)	Total Starch Content (%)	Amylose Content (%)	Amylopectin Content (%)
K1T1	35,36 $\pm$ 0,002 ^c	0,163 $\pm$ 0,003 ^c	13,59 $\pm$ 0,05 ^b	48,08 $\pm$ 0,08 ^c	13,41 $\pm$ 0,04 ^a	34,67 $\pm$ 0,11 ^c
K1T2	36,29 $\pm$ 0,002 ^b	0,164 $\pm$ 0,003 ^c	13,81 $\pm$ 0,09 ^a	48,09 $\pm$ 0,08 ^c	13,43 $\pm$ 0,06 ^a	34,65 $\pm$ 0,14 ^c
K1T3	36,90 $\pm$ 0,003 ^a	0,166 $\pm$ 0,002 ^c	13,86 $\pm$ 0,12 ^a	48,10 $\pm$ 0,08 ^c	13,46 $\pm$ 0,06 ^a	34,64 $\pm$ 0,10 ^c
K2T1	33,02 $\pm$ 0,002 ^f	0,804 $\pm$ 0,004 ^b	11,03 $\pm$ 0,12 ^d	51,24 $\pm$ 0,08 ^b	12,77 $\pm$ 0,05 ^b	38,47 $\pm$ 0,06 ^b
K2T2	34,03 $\pm$ 0,004 ^e	0,808 $\pm$ 0,005 ^b	11,13 $\pm$ 0,09 ^{cd}	51,26 $\pm$ 0,08 ^b	12,80 $\pm$ 0,07 ^b	38,46 $\pm$ 0,10 ^b
K2T3	34,56 $\pm$ 0,002 ^d	0,809 $\pm$ 0,007 ^b	11,20 $\pm$ 0,09 ^c	51,27 $\pm$ 0,08 ^b	12,82 $\pm$ 0,07 ^b	38,45 $\pm$ 0,06 ^b
K3T1	30,56 $\pm$ 0,006 ⁱ	1,612 $\pm$ 0,006 ^a	9,12 $\pm$ 0,09 ^g	52,45 $\pm$ 0,06 ^a	11,53 $\pm$ 0,05 ^c	40,92 $\pm$ 0,05 ^a
K3T2	31,54 $\pm$ 0,014 ^b	1,613 $\pm$ 0,007 ^a	9,36 $\pm$ 0,07 ^f	52,47 $\pm$ 0,08 ^a	11,55 $\pm$ 0,07 ^c	40,91 $\pm$ 0,05 ^a
K3T3	32,35 $\pm$ 0,002 ^g	1,615 $\pm$ 0,006 ^a	9,48 $\pm$ 0,05 ^g	52,49 $\pm$ 0,09 ^a	11,59 $\pm$ 0,07 ^c	40,90 $\pm$ 0,13 ^a

Based on the data presented in Table 2, the more the percentage of kimpul flour used and as the *resting* time increases, the moisture content of the udon produced decreases. This is because the proportion of gluten and amylose in udon decreases.

Gliadin and glutenin can form gluten complexes that have the ability to bind and retain water, causing the water content in the dough to increase [9]. The moisture content of udon is also influenced by the moisture content of the raw materials used.

Wheat flour contains a maximum moisture content of 14.5%, while kimpul flour contains a moisture content of around 7% [6, 10]. In addition, water content is influenced by amylose content. This is because amylose is composed of amorphous areas so that the higher the amylose, the higher the water absorption, the higher the water content [38]. The longer the dough *resting* time, the higher the water content of the udon produced. The *resting* process aims to provide time for the dough to bind water more optimally. The longer the *resting time*, the hydration process of water into the dough to bind with starch granules and gluten will be maximized [12]. According to [19] the longer the *resting* time, the more water will be absorbed.

Based on the variation of flour concentration, the higher the addition of kimpul flour concentration, the higher the ash content. This is because kimpul flour has a higher ash content than wheat flour. Wheat ash content as a food raw material is a maximum of 0.70%. (National Standardization Agency, 2018). The ash content of kimpul flour is 1.76% [15]. The ash content value of kimpul udon is 0.804% - 1.615%. This value is higher than the research conducted by Fatimah (2017) which stated that the ash content of taro udon contained 0.31% ash content. *Resting* time did not significantly affect the ash content of udon [8].

Based on Table 2, it can be seen that the more the percentage of kimpul flour used, the lower the udon protein content. This is because the protein content of kimpul tuber flour is lower than wheat flour. Wheat contains 7-14.45% protein while kimpul flour contains 3.73% protein [6, 11, 20]. The higher the concentration of kimpul flour used, the lower the protein. This is in accordance with research [27] which states that noodles made from kimpul flour contain lower protein

than noodles made from wheat flour.

Starch content increases with the increasing concentration of kimpul flour added. This is because kimpul flour contains higher starch content than wheat flour. The starch content of kimpul flour contains 70.73% starch [31]. Wheat flour contains 70% starch content [21]. Therefore, the more the proportion of kimpul flour used, the more the starch content increases.

Based on the variation of the concentration ratio of wheat: kimpul tuber flour, it can be seen that the higher the substitution of kimpul tuber flour produces udon with decreasing amylose content. This is because kimpul tubers have a lower amylose content than wheat, which is 26.92%, while wheat has an amylose content of 28% [20, 25].

Based on Table 2. above, it is known that the higher the proportion of kimpul flour added, the higher the amylopectin content. This is because kimpul flour contains higher amylopectin, which is 54.74% [20, 26]. While wheat flour contains amylopectin of 50.26% [11].

3.3. Organoleptic Characteristics of Udon

Organoleptic characteristics of udon observed included color, texture, and taste. Based on the *chi-square* test at the $\alpha \leq 0.05$ significance level, the treatment variation of kimpul flour concentration and *resting* time had a significant effect on all parameters. Increasing the use of kimpul flour decreased the panelists' liking value of color, texture, and taste parameters. Increasing the length of *resting* time increased the liking value of texture and taste but decreased the color liking value.

Table 3. Mean Value of Organoleptic Characteristics of Udon.

Treatment Sample	Observation Parameters		
	Color	Texture	Taste
K1T1	6,17 ± 0,70	5,27 ± 1,20	5,27 ± 1,17
K1T2	6,13 ± 0,86	5,33 ± 1,03	5,43 ± 1,04
K1T3	6,00 ± 1,11	5,50 ± 0,97	5,47 ± 1,04
K2T1	4,57 ± 1,07	4,70 ± 1,15	4,70 ± 1,18
K2T2	4,37 ± 1,07	5,03 ± 1,10	4,83 ± 0,80
K2T3	4,10 ± 1,18	5,23 ± 1,22	4,97 ± 1,16
K3T1	3,63 ± 1,16	4,53 ± 1,46	4,63 ± 0,77
K3T2	3,53 ± 0,97	4,60 ± 1,22	4,70 ± 1,00
K3T3	3,27 ± 1,11	4,67 ± 1,22	4,80 ± 1,06

Based on Table 3 above shows that udon made from 100% wheat flour and 0 minutes *resting* time has a color that is more

attractive to panelists than udon made from kimpul flour substitution. This is because kimpul flour contains saponin compounds

[28]. The longer the *resting* time the color hedonic value decreases. This is because the greater the possibility of *maillard* reaction between reducing sugar and protein so that the color is darker and less preferred by [7].

The higher proportion of kimpul flour produced udon with a lower hedonic value of texture. This is because the higher the use of kimpul flour, the proportion of gluten and amylose decreases so that the elasticity of udon decreases so that panelists do not like it [32]. Udon that goes through a longer *resting* process has a higher texture liking value. This is because during the *resting* process, gluten and starch granules in the dough will bind water more optimally and the distribution of water in the dough is more evenly distributed, resulting in udon dough that is more elastic and preferred by panelists.

Udon made from wheat flour and 120 minutes *resting* process was preferred by panelists compared to udon made from kimpul flour without *resting* process. The higher the concentration of kimpul flour added, the favorability value of udon decreased. This is because the higher the concentration of flour added, the stronger the distinctive flavor of kimpul flour that is still unfamiliar to the panelists' sense of taste, because in general udon is made from wheat flour [40].

4. Conclusions

The treatment of variations in the concentration of kimpul flour as a substitute material in the manufacture of udon has a significant effect on all physical, chemical, and hedonic organoleptic characteristics. The addition of kimpul tuber flour concentration decreased the value of elongation, tensile strength, rehydration power, solubility, swelling power, lightness, moisture content, protein content, amylose content, hedonic color, texture, and taste. The addition of kimpul tuber flour concentration increased the cooking loss value, ash content, total starch content, and amylopectin content.

The treatment of variations in resting time had a significant effect on elongation, tensile strength, lightness, moisture content, color hedonics, and taste hedonics. The longer resting time increases the value of elongation, tensile strength, moisture content, color hedonics and taste. The longer the resting time decreases the lightness value. The variation of resting time did not significantly affect cooking loss, rehydration power, solubility, swelling power, ash content, protein, total starch, amylose, amylopectin, and texture hedonics.

Abbreviations

CRD	Completely Randomized Design
ANOVA	Analysis of Variance
DMRT	Duncan Multiple Range Test

Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest.

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