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Characteristics of Gluten Free Biscuit from Purple Sweet Flour, Rice Brands and Coffee Cherry Flour Damat Damat1*, Roy Hendroko Setyobudi2, Noor Harini1, Asmawati Asmawati3, Shazma Anwar4, Cutari Zsazsa Mahesah1 , Mochamad Wachid1, Effendi Andoko5, and Andalusia Trisna Salsabila6 1Department of Food Technology, University of Muhammadiyah Malang, Jl. 14 Raya Tlogomas No. 246, Malang 65144, East Java, Indonesia 2Department of Agriculture Science, Postgraduate Program, University of Muhammadiyah Malang, Malang 65144, East Java, Indonesia 3Faculty of Agriculture, University of Muhammadiyah Mataram, Jl. KH. Ahmad Dahlan No.1, Mataram 83115, West Nusa Tenggara, Indonesia 4Department of Agronomy, University of Agriculture, Peshawar 25130, Khyber Pakhtunkhwa, Pakistan 5College of Agriculture and Natural Resources, National Chung Hsing University, 15 145 Xingda Rd., South Dist., Taichung City 40227, Taiwan (R.O.C.) 6Department of Food Science, Faculty of Agriculture Technology, Postgraduate Program, IPB University, Jl. Raya Dramaga, Bogor 16680, West Java, Indonesia Abstract. 9 This study aimed to analyze gluten free biscuits's from purple sweet potato flour, rice bran flour, and coffee cherry flour; using completely randomized design method. 7 The treatments applied were the ratio of adding purple sweet potato flour, bran flour and coffee cherry flour B0 (100 %: 0 % : 0 %); B1 (80 % : 20 % : 0 %); B2 (60 % : 30 % : 10 %); B3 (40 % : 40 % : 20 %); B4 (20 % : 50 % : 30 %); B5 (0 % : 60 % : 40 %) with four repetitions. The results showed that there was a significant effect between the proportions of the composite use of purple sweet potato flour, bran flour and coffee cherry flour on moisture content, ash content, fiber content, fracture power, color intensity and organoleptic taste. The best formulation was treatment B2 which had 5.05 % moisture content, 2.82 % ash content, 8.80 % protein content, 25 fat content, 05 %, carbohydrate content 58.28 %, crude fiber content 7.63 %, antioxidant activity 83.68 %, color intensity (L = 41.15; a = +5.05; b = +5.97), power broken 6.118 N, texture 4.52 (Slightly not crunchy), taste 5.40 (neutral), and aroma 5.60 (neutral). Keywords: Antioxidant activity, fiber, healty biscuit, waste for food, waste

utilization * Corresponding Author: damatumm@gmail.com E3S Web of Conferences 432, 00008 (2023) 2ndICoN-BEAT 2021 https://doi.org/10.1051/e3sconf/202343200008

1 Introduction Biscuits are one type that is widely consumed by the public. Based on data from the Central Bureau of Statistics for 2018, it is known that as many as 33.314 % of Indonesia's population consumes biscuits more than two times per day. This causes the consumption of wheat flour to continue to increase. In 2021, total wheat imports reached 11.172 × 106 t [1]. Therefore, the rate of consumption of wheat (Triticum L.) flour must be suppressed. In addition, it is known that wheat flour contains gluten. This protein can cause Celiac and Autoimmune disease for those who are gluten intolerant [2]. One solution is to utilize local food ingredients, such as purple sweet potatoes [Ipomoea batatas (L.) Lam.] and rice (Oryza sativa L.) bran. These ingredients are local food ingredients that can grow easily in Indonesia. Bran (rice bran) is a by-product of the rice milling process. Bran amounts to 8 % to 12 % of the total weight of rice grain. Bran has a fairly high nutritional content, namely protein (12 % to 15.6%), fat (15.0 % to 19.7 %), fiber (7.0 % to 11.2 %), carbohydrates (34.1 % to 52.3 %), and ash (6.6 % to 9.9 %) [3]. Purple sweet tubers are one type of carbohydrate source. The carbohydrate content in purple tubers reaches 85.26 %. Also rich in antioxidants [4]. This content allows purple sweet potato to be used as a substitute for making biscuits. Until now, much research on biscuits has been carried out, including biscuits made from pumpkin (Cucurbita L.) flour [5], biscuits from wheat (Triticum) - sweet potato (I. batatas) - soybean (Glycine max (L.) Merr.) composite flour [6], physiological effects of biscuits from purple rice (Oryza sativa L. var. glutinosa) flour [7], and hypoglycemic effects of biscuits from quinoa (Chenopodium quinoa Willd.) flour [8]. Another study was biscuits made from rice bran flour and purple sweet potato flour [9]. It was found that the biscuits produced had high levels of protein and

antioxidant activity but low fiber content. 6 Therefore, other alternative food ingredients are needed to increase the fiber content of biscuits, one of which is by adding coffee cherry fluor (CCF) — It is made from pulp (wet method) or husk (dry method), a by-product of a coffee processor [10]. CCF has excellent potential as a functional food ingredient [11, 10]. Coffee pulp contains several components of macro and micronutrients, including proteins (8 % to 11 %), lipids (0.5 % to 3 %), minerals (3 % to 7 %), carbohydrates (58 % to 85 %), reducing sugars (14 %), caffeine (~1 %), and tannin (~5 %) and 0.2 mg g−1 to 1.9 mg g−1 of 5-O-caffeoylquinic acid compound [12]. Especially CCF as Fe (Iron) source [13, 14] — a nutrient that is lost in Celiac - Autoimmune sufferers, with 2 the impact of anemia [15–17]. 8 Much research has been conducted to utilize CCF as a source of dietary fiber [18–22]. Although there are relatively many studies on CCF as a functional food has never been found. This research was conducted to analyze the physical-chemical characteristics 2 and acceptability of functional biscuits from a composite of purple sweet potato flour, rice bran flour, and coffee cherry flour. 4 2 Materials and methods The equipment used in this study included: Mettler brand analytical balances, stainless steel knives, spoons, basins, slicers, boilers, stoves, pans, mixers, 80.00 mesh sieve, oven, glassware, UV-VIS spectrophotometer, desiccators, and CR -10 Plus Color Reader. Research material: 2 rice bran flour variety IR-64 obtained from Jombang Regency. Purple sweet potato and Robusta coffee pulp obtained from Ngantang District, Malang Regency, margarine, powdered sugar, eggs, skim milk, vanilla, cornstarch, and baking soda. Other materials are materials used in testing the physical and chemical properties of biscuits, 2 10 E3S Web of Conferences 432, 00008 (2023) 2ndICoN-BEAT 2021 https://doi.org/10.1051/e3sconf/202343200008

including phenolphthalein indicator, 0.1 N HCl, 37 % HCl, solid NaOH, distilled water, 96 % ethanol, petroleum ether, 0.325 N H_2SO_4, 1.25 N NaOH, Biuret, BSA (Bovine Serum Albumin) and DPPH (2,2-diphenyl-1-pikrilhidrazil). All chemicals using pro-analytic. 2.1 Research stage This research was conducted in two stages: first, the process

of preparing raw materials, making CCF, and the process of making bran flour. Second, the process of making biscuits, and analyze the physical and chemical properties of biscuits. 2.1.1 Material preparation CCF is made by starting with the pulping process. The coffee pulp will stick to the outer shell of the coffee. The coffee pulp obtained is then dried in the sun for 4 d [23, 10, 13, 14]. After drying, the coffee pulp is made into flour and sieved using an 80-mesh sieve. Rice bran flour of the IR 64 cultivar was obtained from Jombang Regency, East Java, Indonesia. The rice bran flour was dried in an oven at 100 oC for 10 min, then sieved using an 80 mesh sieve [24]. 2.1.2 Process of making biscuits Biscuits are made by modifying the method Baumgartner et al. [25], as Damat et al. [12]. First, weigh all the ingredients according to the measure. The weight of purple cassava flour, rice bran flour, and coffee pulp flour was adjusted according to the experimental treatment. The weight of other ingredients, such as margarine, powdered sugar, eggs, skim milk, vanilla, cornstarch, and baking soda, is adjusted according to the baker's recipe. In the early stages, biscuits are made by mixing margarine and eggs, shaken until pale in color. Next, add powdered sugar, powdered milk, and baking powder to the mixture. Mix the ingredients for 1 min to 5 min, then add vanilla, sweet potato flour, rice bran flour, and CCF according to the treatment. The dough is printed, placed on a baking sheet smeared with margarine, and baked at 150 °C for 15 min. The biscuits that have been baked are left to cool the biscuits and placed in an airtight container [26]. 2.2 Research methods This study was designed using a simple randomized block design (RBD) with a single factor, namely the ratio of purple sweet potato flour, bran flour, and CCF, which consisted of six treatment levels, repeated four times, with the following details: B0 = 100 % purple sweet potato flour : 0 % bran flour : 0 % CCF; B1 = 80 % purple sweet potato flour : 20 % bran flour : 0 % CCF; B2 = 60 % purple sweet potato flour : 30 % bran flour : 10 % CCF; B3 = 40 % purple sweet potato flour : 40 % bran flour : 20 % CCF; B4 = 20 % purple sweet potato flour : 50 % bran flour : 30 % CCF; B5 = 0 % purple sweet potato flour : 60 % bran flour : 40 % CCF. Observer variables included: moisture content, ash content, fat content, carbohydrate content, protein

content, crude fiber content, antioxidant activity test, taste, color, aroma, and texture of biscuits (organoleptic test), and fracture strength. Research data were analyzed using Analysis of Variance (ANOVA). If there is a treatment effect based on the ANOVA results, then proceed with the DMRT follow-up test with a level of α = 5 % [27, 28]. 3 E3S Web of Conferences 432, 00008 (2023) 2ndICoN-BEAT 2021 https://doi.org/10.1051/e3sconf/202343200008

3 Result and discussion 3.1 Physico-chemical properties of raw materials Analysis of physicochemical properties was carried out to determine the moisture content, ash content, fat content, protein content, fat content, carbohydrate content, and antioxidant activity of purple sweet potato flour, rice bran flour, and CCF, as well as free fatty acid content of rice bran flour. The results of the analysis of the initial raw materials are shown in Table 1. The antioxidant activities of purple sweet potato flour, rice bran flour, and CCF were 73.99 %, 79.44 %, and 72.35 %, respectively. The CCF contains hydroxyl cinnamic acids (chlorogenic, caffeine, and ferulic acids) [12, 10]. Antioxidant activity in purple sweet potato flour is due to anthocyanins, peonidin, and cyanins. In bran flour, artisan activity is due to the presence of vitamin B and vitamin E. Table 1. Raw material analysis results. Purple sweet potato flour Coffee cherry flour Rice bran flour Water content (%) 8.53 10.02 7.60 Ash content (%) 2.66 3.21 15.10 Fat level (%) 4.58 1.24 3.80 Protein content (%) 6.81 15.14 7.40 Carb content (%) 70.02 42.73 55.20 Antioxidant activity (%) 73.99 72.45 79.44 Free fatty acid content (%) - - 7.60 Color Normal Normal Normal Form Powder Powder Powder Aroma Normal Normal Normal Table 2. Proximate composition of biscuit products composition of purple sweet potato flour, bran flour, and coffee cherry flour. Treatment Water (%) Ash (%) Fat (%) Proteins % Carbs (%) B0 (100 % PF : 0 % BF : 0 % CCF) 4.01a 0.72a 20.22a 8.42a 65.62a B1 (80 % PF : 20 % BF : 0 % CCF) 5.4ab 2.08b 24.53a 8.71a 58.81a B2 (60 % PF : 30 % BF : 10 % CCF) 5.05ab 2.82bc 25.05a 8.80a 58.28a B3 (40 % PF : 40 % BF : 20 % CCF) 4.59a 3.66c 23.16a 9.29ab 58.90a B4 (20 %

PF : 50 % BF : 30 % CCF) 4.33a 5.22d 23.25a 9.32ab 57.84a B5 (0 % PF : 60 % BF : 40 % CCF) 4.71a 5.93d 22.42a 9.89b 56.52a Note: • The average value followed by the same alphabet letter in the same column is not significantly different according to DMRT α = 5 %. • PF: purple sweet potato flour; BF: bran flour; CCF: coffee cherry flour 4 E3S Web of Conferences 432, 00008 (2023) 2ndICoN-BEAT 2021 https://doi.org/10.1051/e3sconf/202343200008

3.2 Chemical content proximate biscuit products The analysis of variance found that the concentration treatment of the purple sweet potato flour, rice bran flour, and CCF composites had a significant effect on the moisture content, ash content, and protein content of the biscuit products. Treatment of the composite concentration of purple sweet potato flour, rice bran flour, and CCF had no significant effect on the carbohydrate and fat content of the biscuit products. The average value of the results of the biscuit chemical composition analysis is presented in Table 2. The water content's value decreased with the addition of the bran flour formulation, high CCF, and reduced concentration of purple sweet potato flour. This could be due to the influence of the difference in the ratio of the composition of the essential ingredients, so it also affects the ratio of amylose and amylopectin. Amylose and amylopectin are components in starch that play a role in water absorption. The starch content contained in the material will determine the absorption capacity of a material in absorbing water [26]. The resulting ash content value increased with increasing rice bran flour and CCF concentrations. The ash content will increase as the CCF is added. This is because the CCF is included in the coffee fruit rich in minerals such as magnesium and iron [24, 25, 10, 11, 13, 14]. Rice bran flour is also an excellent source of minerals, such as calcium, magnesium, and phosphorus, so it will also affect the ash content of the product. Product protein content increased with increasing rice bran flour and CCF concentrations. This is presumably due to the protein content of the raw material. It is known that rice bran flour used as a raw material has a higher protein content of 12.25 % and CCF protein content of 8.19 %, while the

protein content in purple sweet potato flour is only 0.6 %. The carbohydrate and fat content value had no significant effect with the addition of different composite treatments of purple sweet potato flour, rice bran flour, and CCF. This can be because the three raw materials have high levels of carbohydrates. It is known that the fat content of the product between treatments was not significantly different. This is because it is influenced by the high-fat content in rice bran flour and the low-fat content in purple sweet potato flour and CCF. Based on the quality requirements for biscuit products according to SNI number 01-2973-2011, all the chemical ingredients of the functional biscuit product composite of purple sweet potato flour, rice bran flour, and CCF meet the requirements except for carbohydrate content. Table 3. Crude fiber and antioxidant activity of composite biscuit products of purple sweet potato flour, rice bran flour and coffee cherry flour. Treatment Fiber content (%) Antioxidant activity (%) B0 (100 % PF : 0 % BF : 0 % CCF) 3.35a 76.16a B1 (80 % PF : 20 % BF : 0 % CCF) 5.48b 74.43a B2 (60 % PF : 30 % BF : 10 % CCF) 7.63c 83.68a B3 (40 % PF : 40 % BF : 20 % CCF) 9.23d 83.62a B4 (20 % PF : 50 % BF : 30 % CCF) 11.55e 72.53a B5 (0 % PF : 60 % BF : 40 % CCF) 14.32f 71.77a Note: • The average value followed by the same alphabet letter in the same column is not significantly different according to DMRT α = 5 %. • PF: purple sweet potato flour; BF: bran flour; CCF: coffee cherry flour Biscuit fiber content significantly differed with increasing bran flour and CCF concentrations. The fiber content of the biscuits increased as the amount of rice bran flour and CCF was added, but the fiber content of the biscuits tended to decrease as the concentration of purple sweet potato flour increased. This is due to the less fiber content in 5 E3S Web of Conferences 432, 00008 (2023) 2ndICoN-BEAT 2021 https://doi.org/10.1051/e3sconf/202343200008

sweet potato raw materials than the raw materials for bran flour and CCF. The results of this study are similar to the results of research conducted by Damat et al. [12], which states that adding CCF to biscuits can increase fiber content to 19.48 %. Fiber is good for the body because it cannot be digested in the small intestine but will become a substrate

for BAL (lactic acid bacteria) in the large intestine to produce short-chain fatty acids [29, 30]. The treatment of the ratio of the composition of the raw material for biscuits significantly affected the antioxidant activity of functional biscuits. This is because the three raw materials used, namely purple sweet potato flour, rice bran flour, and CCF, have high antioxidant activity, increasing the product's antioxidant activity. Purple sweet potato flour has anthocyanin pigments, vitamins C and E, lutein, zeaxanthin, and beta-carotene [31]. CCF has high phenolic compounds and natural antioxidants such as anthocyanins, beta-carotene, polyphenols, and vitamin C [10, 13, 14]. In contrast, bran flour is known to have a lot of vitamin E (tocopherol), tocotrienols, and orizanol. This follows the results of previous studies, which showed that the higher the addition of CCF to biscuit products, the higher the product's antioxidant activity would be [23]. Table 4. Breakdown strength and color intensity of composite biscuit products of purple sweet potato flour, rice bran flour, and coffee cherry flour. Treatment Broken power (N (m²)-1) Color intensity Brightness (L) Redness (a+) Yellowish (b+) B0 (100 % PF : 0 % BF : 0 % CCF) 4.55 a 39.82 a 5.63 c 5.2 a B1 (80 % PF : 20 % BF : 0 % CCF) 6.12 ab 40.37 ab 5.40 bc 5.57 a B2 (60 % PF : 30 % BF : 10 % CCF) 9.56 bc 41.15 bc 5.05 bc 5.97 a B3 (40 % PF: 40 % BF : 20 % CCF) 10.55 bc 41.55 b 4.70 ab 7.22 b B4 (20 % PF : 50 % BF : 30 % CCF) 11.31 c 41.57 c 4.30 a 7.57 b B5 (0 % PF : 60 % BF : 40 % CCF) 12.40 c 42.70 d 4.05 a 9.42d Note: • The average value followed by the same alphabet letter in the same column is not significantly different according to DMRT α = 5 %. • PF: purple sweet potato flour; BF: bran flour; CCF: coffee cherry flour The cracking power of biscuits increased with the addition of bran flour and CCF. This is due to comparing the three composite flours used as raw materials. The three composite flours, purple sweet potato flour, rice bran flour, and CCF, have high fiber content. The high fiber content in composite flour can affect the cracking power of biscuits [32]. Raw materials influence differences in the level of brightness of biscuits. The brightness value will increase with the increasing concentration of rice bran flour and CCF addition. Conversely, the brightness level will decrease as the rice bran flour ratio increases. This is because bran flour has

a light brown color. The reddish value indicates a reduced purple sweet potato flour concentration in the biscuits. 11 This could be because the purple sweet potato has anthocyanin pigment, which can increase the reddish value of the biscuit. The use of purple sweet potato flour will produce a thicker colored biscuit [9]. The yellowness value in the biscuit yellowness intensity table shows a decrease with 2 the decrease in purple sweet potato flour and the increase in rice bran flour and CCF. The resulting yellow color can be caused by bran flour. This is because bran has a light brown color, while CCF has a dark brown color. In addition, the brown color of the biscuits can also be caused by the Maillard reaction that occurs when the biscuits are baked. An uncontrolled Maillard reaction can cause a dark brown product [33]. Maillard reactions can occur in biscuits because biscuits are 5 known to contain reducing sugars and amine groups from amino acids or proteins [34]. 6 1 E3S Web of Conferences 432, 00008 (2023) 2ndICoN-BEAT 2021 https://doi.org/10.1051/e3sconf/202343200008

Table 5. Organoleptic composite biscuit products of purple sweet potato flour, rice bran flour, and coffee cherry flour. Treatment Texture Scent Flavor Favorite B0 (100 % PF : 0 % BF : 0 % CCF) 4.55 a 39.82 a 5.63 c 5.2 a B1 (80 % PF : 20 % BF : 0 % CCF) 6.12 ab 40.37 ab 5.40 bc 5.57 a B2 (60 % PF : 30 % BF : 10 % CCF) 9.56 bc 41.15 bc 5.05 bc 5.97 a B3 (40 % PF : 40 % BF : 20 % CCF) 10.55 bc 41.55 b 4.70 ab 7.22 b B4 (20 % PF : 50 % BF : 30 % CCF) 11.31 c 41.57 c 4.30 a 7.57 b B5 (0 % PF : 60 % BF : 40 % CCF) 12.40 c 42.70 d 4.05 a 9.42d Note: • The average value followed 4 by the same alphabet letter in the same column is not significantly different according to DMRT α = 5 %. • PF: 1 purple sweet potato flour; BF: bran flour; CF: coffee cherry flour Biscuits were tested for their acceptability by 25 trained panelists. The test results obtained an assessment score that the texture preference value decreased with increasing concentrations of rice bran flour and coffee pulp flour. The nature of the basic ingredients of bran flour and coffee pulp flour can cause this. Coffee bran and pulp, which have a high fiber content, make the biscuits not crunchy in texture and tend to be hard when consumed. The higher

concentration of rice bran flour and coffee pulp flour obtained the organoleptic value of the biscuit taste. The taste of the biscuit became bitter, so the panelists stated that the biscuit taste was not good. 4 This is due to the bitter taste of bran flour and CCF. Coffee cherry flour is 5 known to contain dietary fiber, polyphenols, caffeine, and tannins, which will affect the biscuit race [35, 10, 13, 14]. The results of the organoleptic test revealed that the value of biscuit aroma tended to decrease with decreasing concentrations of 1 purple sweet potato flour and increasing concentrations of rice bran flour and CCF. The aroma obtained is not pleasant to slightly pleasant. This can occur 2 due to the oxidation of compounds in purple sweet potato flour, rice bran, and CCF, which causes an unpleasant odor. The preference value of panelists decreased with increasing concentrations of rice bran flour and CCF. Rice bran quickly becomes rancid and causes unwanted odors. Rice bran contains many unsaturated fatty acids and lipase enzymes [36], which are easily oxidized. 4 Conclusion Based on the study's results, it was concluded that biscuits made from a composite of 1 purple sweet potato flour, rice bran flour, and coffee cherry flour can be grouped as functional biscuits. The biscuits have 83.68 % 3 antioxidant activity and 7.63 % crude fiber content. The best formulation was treatment B2 (60 % purple sweet flour, 30 % bran flour, 10 % coffee cherry flour) which had a 5 moisture content of 5.05 %, ash content of 2.82 %, protein content of 8.80 %, fat content of 25.05 %, carbohydrate content 58.28 %, crude fiber content 7.63 %, antioxidant activity 83.68 %, color intensity (L = 41.15; a = +5.05; b = +5.97), power broken 9.56 N, texture 4.52 (somewhat not crunchy), taste 5.40 (neutral), and aroma 5.60 (neutral). References 1. S. Bodamaev, Rahmitha, K.F. Tandipanga. Indonesia Food Price Bulletin - April 2022, Special Focus: Palm Oil. World Food Programme (2022) https://docs.wfp.org/api/documents/WFP-0000138863/download/ 2. R.M. Masot, M.J. Munoz, M.H. Lopez, M.F. Alemany, V.M.N. Lopez, T. Nestanes, Nutrients, 15,7: 1761 (2023) https://doi.org/10.3390/nu15071761

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