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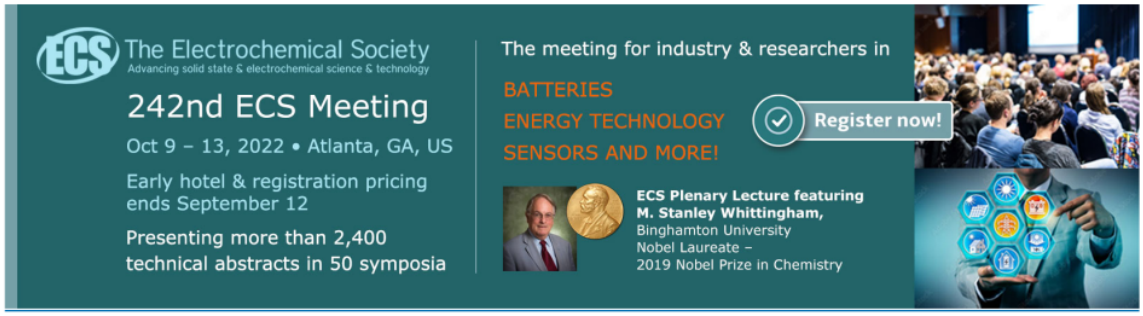

The Addition Effect of Cinnamon Powder (*Cinnamomum burmanii*) on The Characteristics of Gluten-free Cookies Made From Tempeh and Mocaf Flour

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Abstract. The research aimed to determine the characteristics of gluten-free cookies made from tempeh and mocaf flour with the addition of cinnamon powder and to determine the formulation with proper treatment. The research design used a completely randomized design (CRD) with five treatments and three replications. Data analysis used Analysis of Variant (ANOVA) and if the results were significantly different, followed by the DNMRT (Duncan's New Multiple Range Test) tests at 5% level. The observations were hardness test, water content, ash content, protein content, fat content, carbohydrate content, amino acid content, crude fiber content and free fatty acid content and antioxidant activity test. The best treatment obtained in the treatment with the addition of cinnamon powder was 0,32%. The results for cookies characteristic were hardness level of 48,15 N/cm², moisture content 3,45%, ash content 0,50%, protein 7,90%, fat 37,0%, carbohydrates 51,15%, crude fiber 0,04%, FFA 0,87%, antioxidant activity 31,82%, energy 569,20 kcal/100g. The Amino acid score of the protein sample is 15, with the main limiting amino acid being methionine (methionine+cystine) and the second limiting amino acid being lysine which is 43.

Keywords: Amino Acid, Cinnamon, Cookies, Gluten Free, Mocaf Flour, Tempeh

1. Introduction

Cookies are snacks that can be produced using a variety of flours, including flour that does not contain gluten and enrich with protein [1]. Cookies produced from gluten-free flour can be consumed by individuals who are allergic to gluten, such as those with celiac disease and autism. Mocaf (Modified Cassava Flour) is a product of Manihot esculenta that is processed by modifying the flour with fermentation by lactic acid bacteria (BAL) so that it changes its functional properties. Microbes that grow during fermentation will produce pectinolytic and cellulolytic enzymes that can destroy the cell walls of cassava, resulting in the liberation of starch granules. Mocaf flour made from yam flour and othet tuber where the color of flour is white or depend on the source and high viscosity The mocaf industry in Indonesia was developed [2]. The use of tempeh in the manufacture of cookies aims to have a better nutritional content, especially protein. At 100 g of tempeh, there are 20.8 g of protein contained in it.

These cookies are added cinnamon powder as a flavor so that the cookie tastes good. Cinnamon (Cinnamomum burmanii) is widely used as a kitchen spice and medicine. Cinnamon contains cinnamaldehyde, eugenol, cinnamic acid, catechins, epicatechin, and other polyphenol compounds. This phytochemical compound makes cinnamon potential an antioxidant and in addition to as a flavor enhancer of cuisine [3].

Excessive use of cinnamon powder is thought to give a pleasant aroma. Based on the above description, research is carried out on the effect of adding cinnamon powder on the characteristics of gluten-free cookies made from tempeh and mocaf flour. From this study, researchers hope to add alternatives of processed food products made from mocaf flour, tempeh, and cinnamon powder and reduce the dependence or use of wheat flour, especially in the manufacture of cookies.

2. Materials and Method

2.1 Place and Time of Implementation

The research was conducted at the Laboratory of Chemistry, Biochemistry of Agricultural Products and Food Nutrition, Laboratory of Technology and Engineering of Agricultural Products Process and Laboratory of Central Instruments, Department of Agricultural Products Technology, Faculty of Agricultural Technology, Andalas University.

2.2 Chemicals and tools

The ingredients used in the study were cinnamon bark from Padang Supermarket, mocaf flour from Mocafine, tempehh from Rumah Tempeh Azaky, refined sugar, eggs, margarine, and cornstarch. Materials for analysis consist of equates, HCl, H2SO4, NaOH 0.1 N, alcohol, PP Indicator, ethanol 95%, KOH, HCl0, 5N, hexane solvent, 96% ethanol, DPPH (1.1–diphenyl-2-picrylhydrazyl).

The tools used in this study are glass tools, ovens, scales, baking trays, 60 mesh, spoons, trays, clamp handles, test tubes, porcelain cups, Kjeldahl, Erlenmeyer, decimators, and soxhlets.

2.3 Research Design

Design research was used a Complete Random Design with five treatments and three repeats. If the variant test (F count) shows a real difference, floowed by using Duncan's New Multiple Test (DNMRT) at the 5% stage where there was significant difference. The treatments used in this study included 5 treatments, namely; Treatment A = without cinnamon powder,Treatment B = Cinnamon powder 0.32%, Treatment C = Cinnamon powder 0.64% , Treatment D = Cinnamon powder 0.96%, Treatment E = Cinnamon powder 1.28%.

2.4 The Process of Making Cinnamon Powder

The cinnamon washed than lined to dry. Reduced size up to 5-10cm. and blended until smooth until it becomes powdered. The powder then sieve for 60 mesh. The cinnamon powder than keep in plastic bag.

2.5 The Process of Making Tempeh Granule

Fresh tempeh is cut into small sizes of 5-10 cm. The tempeh that has been cut into small pieces is then crushed using crusher. Tempeh is roasted using a temperature of 50 °C for 30 minutes.

2.6 The Process of Making Gluten-Free Cookies

Put in a container of the following ingredients: butter, sugar flour, and egg yolk stir for 5 minutes using a mixer. Then add the filtered mocaf flour first, corn starch, cinnamon powder formula, skim milk, tempeh, vanilla, salt, and dried grated tempeh, stirring using a low-speed mixer until the dough is evenly distributed. Print the cookie dough and arrange it on a baking sheet that has been smeared with margarine. Bake the dough in the oven at 180°C for 30 minutes until cooked through. Remove the cookies from the oven. Once cool, put in an airtight container and ready to be analyzed. In Table 1. Presented formula making cookies:

Table 1. Cookies Gluten Free Formula with Addition of Cinnamon Powder

Composition	Treatment				
	A	B	C	D	E
Mocaf flour(g)	100	100	100	100	100
Cinnamon powder (g)	0	1	2	3	4
Tempeh (g)	80	80	80	80	80
Margarine(g)	80	80	80	80	80
Refined sugar (g)	30	30	30	30	30
Egg yolk (g)	15	15	15	15	15
Vanilla(g)	1	1	1	1	1
Salt(g)	1	1	1	1	1
Skim milk(g)	5	5	5	5	5

2.7 Observation

Observations made on raw materials tempeh, tempeh granules, mocaf flour, and cinnamon powder consist of water content, ash content, protein content, fat content, and carbohydrate conten, while in cookies products in the form of analysis of physical properties of hardness, chemical analysis (water content, ash content, protein content, fat content, amino acid content, crude fiber levels, carbohydrate levels, amino acid test, trans fat test, free fatty acid test) and antioxidant activity.

3. Results and Discussion

3.1 Analysis of Raw Materials

Analysis of raw materials, namely cinnamon powder, mocaf flour, tempehh, and tempehh granules, is served in Table 2.

Table 2. Average Value of Analysis of Cinnamon Powder, Mocaf, Tempeh, and Tempeh Granules

Analysis	CP (%)	MF(%)	T(%)	TG(%)
Water content	10.30	9.67	50.22	10.67
Ash content	2.80	0.34	0.02	1.36
Fat content	2.00	2.94	13.21	6.42
Protein content	5.47	2.21	28.25	47.08
Carbohydrates content	79.43	84.84	8.30	34.47

Note: CP (Cinnamon Powder), MF (Mocaf Flour), T (Tempeh), TG (Tempeh Granules)

The water content of cinnamon powder obtained in this study is 10.30%. So that the water content obtained in this study has met existing standards. The water content of mocaf flour obtained was 9.67%. The water content of tempeh obtained in this study was 50.22%, while the water content in tempeh grains was 10.67%. The water content of tempeh granules is lower than fresh tempeh; this is due to heating so that some of the water evaporates. Water content is a factor that has an important influence on the durability of the processed material. The lower the water content contained in an ingredient, will slow the growth of microbes and make the food more extended shelf life[4].

The level of cinnamon powder ash obtained in this study was 2.8%. This result has met requirement a maximum ash content of 3%. The level of mocaf flour ash was obtained by 0.34%. The level of tempeh ash was obtained by 0.02%. The most abundant minerals in purple sweet potatoes are potassium, sodium and phosphorus, calcium, magnesium, and iron. This mineral has a role as a building and regulatory substance in the body's metabolism[5]

The protein content of mocaf flour obtained in this study was 2.21%. The protein content of cinnamon powder was obtained by 5.47%. The level of tempeh protein obtained was 28.25%. When compared with lower levels of tempeh protein compared to tempehh grain protein levels of 47.08%. The fat content of mocaf flour obtained in this study was 2.94%. The fat content of tempeh granules obtained was 6.42%. The fat content obtained by cinnamon powder was 2.0%. The carbohydrate content of mocaf flour obtained in this study was 84.84%. The carbohydrate content in tempeh is 8.30%, while the carbohydrate in higher tempeh granules obtained was 34.47%. The carbohydrate content obtained by cinnamon powder was 79.43%. A previous research about the addition of soybean flour and mocaf flour increase the protein content in biscuits[6].

3.2 Cookies Hardness Test

The average value of cookies hardness tests with cinnamon powder can be seen in Table 3.

Table 3. Average Value – Cookies Gluten Free Hardness Test

Treatment	Hardness (N/cm²)
A CP 0%	53.64 ±3.16 a
B CP 0.32%	48.15 ±8.22 a b
C CP 0.64%	47.09 ±8.89 b
D CP 0.96%	40.47 ±3.85 b c
E CP 1.28%	32.46 ±5.20 c

Note: CP: Cinnamon Powder; The numbers in the same column are followed by lowercase letters that are not the same real difference at the level of 5% according to DNMRT.

Based on the data in Table 3, it can be seen that the hardness test of cookies by mixing the cinnamon powder with raw materials tempeh and mocaf flour produced ranges from 32.46 N / cm2 – 53.64 N / cm2 with a diversity of 14.21%. The cookie hardness test with the highest addition of cinnamon powder was produced on treatment A (without the addition of cinnamon powder) with an average value of 53.64 N/cm2. While the lowest hardness test was produced on the E treatment (with the addition of cinnamon powder as much as 1.28%) with an average rate value of 32.46 N / cm2, the hardness value of cookies with the addition of cinnamon powder gives a noticeable different effect at a fundamental level of 5%.

The hardness of food is influenced by the water content contained in it. If the water content of a product is high, then the product's hardness will be Lower because the high water content can make the material experience softening. Based on the water content analysis conducted on cookies, the highest water content is owned by E treatment cookies (with cinnamon powder 1.28%). This is evidenced by the low hardness test on cookies with the E treatment.

3.3 The chemical Properties of cookies

Based on research that has been done, the average water content, ash levels, protein levels, and fat content of cookies are presented in Table 4.

Table 4. Average Value of Water Content of Protein and Fat Content of Gluten Free Cookies

Treatment	Water Content (%)± SD	Ash Content (%)±SD	Protein Content(%) ±SD	Fat Content (%) ±SD
A CP 0%	2.95±0.35 a	0.31 ±0.01 a	8.38 ±0.35 a	38.00 ±0.0 a
B CP 0.32%	3.45 ±0.15 a	0.50 ±0.17 ab	7.90 ±0.65 ab	37.00 ±1.0 b
C CP 0.64%	3.75 ±0.15 ab	0.75 ±0.08 bc	7.31 ±0.60 bc	36.00 ±2.0 c

D CP 0.96%	4.45 ±0.85	bc	1.04 ±0.23	cd	6.70 ±0.60	cd	35.00 ±2.1	d
E CP 1.28%	4.97 ±0.58	c	1.21 ±0.18	d	5.76 ±0.43	d	34.00 ±4.00	e

Note: CP: Cinnamon powder; The numbers in the same column are followed by lowercase letters that are not the same real difference at the level of 5% according to DNMRT.

3.3.1 Water Content. The results obtained showed that the higher the addition of cinnamon powder, the more water content in the cookie products produced. The high water content in cookies comes from cinnamon powder which has a water content of 10.30%. This is due to the presence of compounds in cinnamon, among others: phenols, saponins, alkaloids, flavonoids, and tannins that contain hydroxyl groups that can bind to water[7].

According to the quality standard SNI 01-2973-2011, which is about the quality requirements of cookies and biscuits attached, the maximum water content is 5%. The cookie products produced with cinnamon powder have been obtained results that meet SNI quality standards [8].

3.3.2 Ash Content. Based on research that has been carried out, it is known that the ash levels of cookies by mixing Cinnamon powder exert a noticeable different influence at the level of 5%. The results of the variety of fingerprints showed that the ash levels of cookies with the addition of cinnamon powder had a natural effect. Table 4 shows the lowest ash levels found in A treatment cookies (Addition of cinnamon powder 0%) with an ash content of 0.31% and the highest ash levels found in E treatment cookies (with the addition of cinnamon powder 1.28%) with an ash content of 1.21%.

According to the quality standard SNI 01-2973-2011, which is about the quality requirements of cookies and biscuits attached, the maximum ash content is 1.6%. The cookie products produced with the addition of cinnamon powder have obtained results that meet SNI quality standards[8].

3.3.3 Protein Content. Based on Table 4, it can be seen that the levels of protein cookies produced range from 5.76% - 8.38%. The highest levels of protein are produced in treatment A (without addition) cinnamon powder) with an average value of 8.38%, while the lowest protein levels are made on the E treatment (Addition of cinnamon powder 1.28%) with an average value of 5.76%. The higher the addition of cinnamon powder, the lower the protein content produced. The lower the addition of cinnamon powder, the higher the protein levels of cookies made. The high protein content in cookies comes from tempeh granules which have a protein content of 47.08%.

3.3.4 Fat Content. Based on research that has been done, it is known that the fat content of cookies by mixing cinnamon powder gives a noticeable different influence at the level of 5%. Based on data in Table 4, it can be seen that the average fat content of cookies produced ranges from 34.0%-38.0%, with a diversity coefficient of 6.23%. From the research results, the fat content obtained by the addition of cinnamon powder has an influence on fat content in gluten-free cookie products made from tempeh and mocaf flour with the addition of cinnamon powder.

Based on research done, the average levels of carbohydrates, coarse fiber, and energy from cookies are obtained from table 5 below.

Table 5. Average Value of Carbohydrates, Coarse Fiber and Energy Gluten Free Cookies

Treatment	Carbohydrate(%)± SD		Crude Fiber(%)± SD		Energy	
A CP 0%	50.36 ±0.02	a	0.04 ±0.01	a	580.97 ± 9.66	a
B CP 0.32%	51.15 ±1.55	ab	0.04 ±0.01	a	569.20 ± 14.87	a
C CP 0.64%	52.19 ±2.51	bc	0.06 ±0.00	b	562.00 ± 57.86	a
D CP 0.96%	52.81 ±2.57	cd	0.06 ±0.00	b	553.04 ± 22.73	a
E CP 1.28%	54.06 ±3.42	d	0.08 ±0.00	c	545.28 ± 46.7	a

Note: CP: Connamon powder; The numbers in the same column are followed by lowercase letters that are not the same real difference at the level of 5% according to DNMRT.

3.3.5 Carbohydrate Content. Determination of protein levels in this study using the method by different, the results of the analysis of carbohydrate levels with various treatments can be seen in Table 5. Based on the data in Table 5, the levels of carbohydrate cookies produced range from 50.36% - 54.06%, with a co-efficient diversity of 4.46%. The highest carbohydrate levels were made on the E treatment (addition of cinnamon powder1.28%) with an average value of 54.06%,

While the lowest carbohydrate levels are produced in treatment A (Addition of cinnamon powder 0%) with an average value of 50.36%. The cinnamon powder increase the carbohydarte content in product[9].

3.3.6 Crude Fiber Content. Crude fiber levels in cookies with the addition of cinnamon powder range from 0.04%-0.08%. The lowest levels of crude fiber are produced in treatment A (Without the addition of cinnamon powder) with an average value of 0.04%, while the highest coarse fiber content was produced at the E treatment (Addition of cinnamon powder 1.28%) with an average value of 0.08%. The results obtained showed that the higher the addition of cinnamon powder to each treatment, the higher the coarse fiber levels produced in cookie products. The content of coarse fiber in cinnamon is 31.24%[10]. This is what causes an increase in the range of crude fiber cookies with cinnamon powder.

3.3.7 Energy Value, Free Fatty Acids Content, Antioxidant Activity. Table 5 shows that the energy value of cookies produced ranges from 545.28 - 580.97 kcal/100 g. The lowest energy value is in treatment E at 545.28 kcal/100 g, while the highest energy value is at treatment A of 580.97 kcal/100g. The addition of cinnamon powder with tempeh raw materials and mocaf flour does not affect the energy value of cookies.

The more cinnamon powder additions, the lower the energy value of cookies. The less the addition of cinnamon powder, the higher the energy of cookies. Fat is a source of energy. The higher the addition of cinnamon powder, the lower the fat content and the lower the energy value created in cookie products.

Based on research that has been done obtained average levels of free fatty acids and antioxidants from cookies presented in Table 6.

Table 6. Average Value of Free Fatty Acids and Antioxidant Activity of Gluten Free Cookies

Treatment	Free fatty acid (%) + SD		Antioxidant Activity (%)+ SD	
A CP 0%	0.82 ±0.01	a	26.94±5.13	a
B CP 0,32%	0.87 ±0.005	b	31.82 ±0.21	ab
C CP 0.64%	0.88 ±0.01	b	33.57 ±1.86	b
D CP 0.96%	0.93 ±0.005	c	37.12 ±2.90	bc
E CP 1.28%	0.98 ±0.01	d	40.47 ±3.78	c

Note: CP: Cinnamon powder

Based on Table 6, The analysis of free fatty acid levels in the resulting cookies ranged from 0.82% - 0.98%. The highest free fatty acids are produced on treat E (without cinnamon powder) with an average value of 0.98%. In comparison, the lowest free fatty acids were produced in treatment A (1.28% addition of cinnamon powder) with an average value of 0.82%.

The data obtained show that the more cinnamon powder is used, the value of free fatty acids. Has an increase. This is thought to be due to the water content contained in cookies with the addition of cinnamon powder, then the moisture content of cookies is higher. Water content is one of the factors that affect the onset of free fatty acids. High water content in products with high-fat content can accelerate hydrolysis reactions of fats into free fatty acids that result in increasing numbers of Free fatty acids in the product[11]. Increased number of free fatty acids in this product will cause the product to become rancid quickly[12].

Antioxidants are compounds that can delay, slow down and inhibit oxidation reactions in food and drugs, where they are easily oxidized so that other cells avoid radicals[13]. Based on Table 6, the analysis of the antioxidant activity in the resulting cookies ranges from 26.94% - 40.47%. The highest antioxidant activity was generated in treat E (addition of cinnamon powder 1.28%) with an average

value of 40.47%. In comparison, the lowest antioxidant activity was developed in treatment A (without the addition of cinnamon powder) with an average value of 26.94%. Table 6 showed the higher the addition of cinnamon powder, the higher the antioxidant activity produce, the less added cinnamon powder, the lower the antioxidant activity.

3.3.8 Amino Acid Score and Trans Fatty Acid Content. An average score of amino acids and trans fatty acid from cookies was obtained from Table 7 below.

Table 7. Amino acid Score and Fatty Trans Gluten Free Cookies

Amino acid (mg/g)	FAO Standard (2013)	Cookies treatment B	Amino acid Score	Limiting amino acid
Isoleusin*	21	56	100	
Leusin*	55	94	100	
Lysin	96	42	43	43
Metionin +Sistin	69	10	15	15
Fenilalanin+Tirosin*	33	144	100	
Treonin	44	62	100	
Valin*	22	60	100	
Trans fat	Not detected			

*) If the calculation number >100, it is written as 100.

The chemical score method is simplified because the limiting amino acids (limiting AA) in most foods are lysine, methionine (methionine + cystine), and sometimes tryptophan. So the calculation of chemical scores is only done on these amino acids.

The result of Table 7. showed that the lowest amino acid is methionine (methionine+cystine) was 15, while the second-lowest number in lysine is 43. This means that the chemical score of the protein sample was 15, with the primary limiting amino acids being methionine (methionine+cystine) and the second limiting oxin being lysine. The test results obtained in Table 7. cannot detect trans fat content in the content of products with the best treatment B treatment (addition of cinnamon powder 0.32%). Epidemiological research has shown that trans fats are a risk factor for coroner's heart disease[14].

Figure 1. Cookies with various treatments

4. Conclusions

Based on research that has been done, it can be concluded that the addition of cinnamon powder flour in the manufacture of cookies has a real influence on hardness, water content, ash content, fat levels, protein levels, free fatty acid levels, energy values, coarse fiber levels, and antioxidant activity, but has no natural effect on carbohydrate levels. The best products in making cookies with the addition of cinnamon powder are treatment B, with the average results of chemical analysis as follows: water content (3.45%), ash content (0.50%), protein content (7.90%), fat content (37.00%), free fatty acids

(0.93%), coarse fiber content (0.04%), carbohydrates (51.15%), energy value (569.09 kcal/100g) and antioxidant activity (31.82%). For physical analysis, hardness (48.15 N/cm2). The lowest amino acid is methionine (methionine+cystine) which is 15, while the second-lowest number is lysine, which is 43. This means that the chemical score of the protein sample is 15, with the primary limiting amino acid being methionine (methionine+cystine) and the second limiting amino acid being lysine.

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