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Effect of Anchovies' Fish Meal Concentration and Heat Moisture Treatment Modification Time on The Quality of Dry Noodles

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Abstract. Sago a raw material for flour for noodles has the potential to be developed and becomes a challenge to be able to compete with noodles made from wheat, which is an imported ingredient. However, the use of noodles made from sago is very limited because it does not have gluten and lacks functional properties, besides that it is also low in protein. The effect of anchovies' fish meal concentration and heat moisture treatment modification time were studied. The chemical, color, resistant starch, and acceptability of dry noodles were evaluated. The experiments were a completely randomized factorial design with two factors, namely anchovies' fish meal concentration (0, 5, and 10%) and duration of HMT modification (24 hours and 32 hours). Each treatment was repeated three times. The concentration of anchovies' fish meal had been significantly different on protein content, water content, color, and acceptability of dry noodles. Heat Moisture Treatment (HMT) modification duration influenced water content, color, and acceptability, but did not affect protein content. The interaction of anchovies' fish meal with a concentration of 10% and modification time of HMT for 32 hours can increase protein content, and color, and produce highly resistant starch. The resistant starch content in dry noodles was 16.84%-25.14%. Acceptance analysis with anchovies' fish meal concentration for 32 hours of HMT modification yielded the preferred aroma and taste values of 5.07 and 5.27, respectively. Keywords: anchovies' fish meal, dry noodles, HMT, sago starch

1 Introduction

Indonesia is in second place after China for consumption of noodles with a total demand of 13.270 million packages and 12.640 million in 2020. Noodles are one of the most popular foods in the world which are generally made from wheat and are a predictive indicator of

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the quality of a noodle. The gluten content in wheat contributes to the viscoelasticity and texture of the dough, in addition to affecting the resistance to extensibility dan resulted in higher water absorption [1]. The use of wheat for the manufacture of noodles makes wheat imports in Indonesia increase by 5% annually. This could reduce the country's foreign exchange [2]. On the other hand, wheat has allergenic properties that affect some groups of people. This causes the demand for gluten-free products to increase.

This allergenic nature of wheat can be diversified with local food. The most strategic local foods as raw materials for noodles are sago, sweet potatoes, corn, and cassava which can be produced domestically [3]. The popularity of non-gluten noodles is increasingly known as starch noodles, which are noodles that are processed from various plant sources. Food sources of high carbohydrates that have a role in supporting food diversification is sago. Sago is commodity that produces large amounts of carbohydrates that grow in stable ecosystem dynamics and sustainable agriculture. In addition, sago has the potential used food ingredients to replace rice because have a high content of iron, phosphorus, calcium, and carbohydrates, as well as energy [4].

Sago has been developed in various types of products including noodles, jelly, sago pearls, soups, puddings, biscuits, and many more [5]. The advantage of sago starch compared to other cereal starches is that it has a softer starch paste than other cereal starch pastes, but is like tapioca paste, sweet potato, and waxy corn starch. Judging from the physicochemical properties, sago has low adhesive power, high cohesive power, and a harder gel, compared to other starches. Sago does not have gluten, but through the gelatinization process, it can form an irreversible gel. This process is used to get a firm texture, resulting in the dough which is then processed with an extruder to form elastic noodle strands.

Sago has a high carbohydrate content, but low protein and other functional properties resulting in minimal innovation. It is necessary to increase the nutrient content sago through animal protein fortification. Food fortification is a method for reducing micronutrient deficiencies and regulating the addition of micronutrients to food. Animal protein can increase nutrient content of sago is anchovies. Anchovy has high nutritional and economic value because it is used as a side dish for people's food Indonesian every day. Anchovies besides being easy to obtain and process in various forms of cooking menus, can also be consumed by all ages [6]. Anchovies fish meal was a protein and ash content of 70,16% and 14.86% respectively.

Sago can be made into resistant starch with modification HMT. This method does not use chemicals as reagents so that it does not leave residue on the modified starch produced. This method is carried out by heating the sago granules above their gelatinization temperature under conditions of limited water content so that they do not cause gelatinization but allow the starch to undergo compact changes in amylose and amylopectin [7].

Modification of sago starch chosen to make resistant starch has health benefits. Resistant starch has the desired physicochemical properties, namely increasing viscosity, ability to bind water, swelling, and forming a gel so that it can be applied to various food products. This utilization as a raw material from sago-based noodles which is enriched with anchovy protein. The effect of concentration of anchovy flour addition and heat moisture treatment modification time were studied. The chemical, color, resistant starch, and acceptability of dry noodles were evaluated.

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2 Material and methods

The raw materials in the research are sago flour and anchovies each obtained from Ambon and Blanakan Subang. The freshly anchovies were weighed, put in styrofoam that has been coated with ice, and was transported to the laboratory for processing it into fish meal.

2.1 Modified starch process

Modification of sago starch is carried out physically namely the length of heating time refers to [7]. making modified starch using the Heat moisture treatment (HMT) method. Sago whose water content is known is adjusted back to 25% by spraying distilled water. The amount of distilled water sprayed is determined based on mass balance calculations.

Wet starch with a water content of up to 25% is then placed in a closed pan and stirred. The starch was left in the refrigerator for 12 hours to uniformize the water content. A baking sheet containing wet starch was heated in an oven at 120ºC for 24 hr and 32 hr. Then, tempering was carried out which was then dried at 50ºC for 4 hr. The final step is the starch is ground and sieved through 60 mesh. Then the resistant starch test as the main ingredient for making dry sago anchovies noodles.

2.2 Manufacture noodles process

Noodle production with HMT modification time of 24 hr and 32 hr. The main ingredient for making noodles is 100% modified sago starch added with concentrations of 0%, 5%, and 10% anchovies' fish meal then the addition of 2% salt that has been dissolved in 25% water. The dough was homogenized for 15 minutes, then pregelatinized 30 min. Next, the formation of noodles at 75ºC, then tempering of 27ºC, for 48 hours.

2.3 Chemical analysis

The chemical analysis determined protein and water content. Protein content using the Dumas combustion method [8], and water content was analyzed using the method of [9].

2.4 Color

Color testing using a chromameter refers to [10]. The chromameter is calibrated and measurements values of a, b, and L. Value a is color green (red-green mixture), value b color blue (blue-yellow mixture), and L (brightness). Color measurement is based on the whiteness index using the formula as in Equation

$$W = 100 - \sqrt{(100 - L)^2 + a2 + b2} \quad (1)$$

2.5 Resistant Starch

The resistant starch analysis refers to the AOAC method [11]. 1 g sample was suspended in 0.08 M phosphate buffer solution (50 mL), pH 5.5. Then incubated at 100°C until gelatinized. The sample was cooled to room temperature (27°C) until the solution temperature reached 65°C. After that, the samples were added with 10 μL of α-amylase enzyme (Megazyme, USA) and incubated at 65°C for 30 minutes. After incubation, 1 N HCl was added to the suspension (Merck, Germany), until a pH of 4.5 was reached. At this pH, 20 µL of the amyloglucosidase enzyme mixture (Megazyme, USA) was incubated at 60°C, 60 minutes. A 10 µL sample was taken and 1 mL glucose oxidase FS was added (Diagnostic System International, Holzhein, Germany). Samples were incubated 20 min at 20±25°C. The calibration was carried out using a UV-Vis spectrophotometer (Genesys 10 S, China) at λ 500 nM. RS content (%) is calculated based on the formula as in Equation 2.

$$\% \text{ RS} = \frac{1-Gx0{,}9}{berat\ sampel} \text{ x } 100\% \quad (2)$$

2.6 Acceptability

Acceptance evaluated the dry noodles for color, taste, texture, and aroma by 30 untrained panellists' using a hedonic test with a scale of 1-6.

2.7 Statistical analysis

Data analysis using SPSS Ver. 23.0. Analysis ANOVA to determine whether there was an effect of each treatment. If it is significant different (p<0.05), then Duncan's further test.

3 Result and discussion

All samples of dry noodles were analyzed for chemical (protein and water), color, resistant starch, and acceptability (taste, color, texture, and aroma).

3.1 Chemicals

3.1.1 Protein content

Protein content of 0.20-8.21% (Figure 1). Anchovies fish meal concentration had been significant different (p<0.05) on the protein of dry noodles, while the interaction between HMT modification time and anchovies fish meal concentration had been not significant different (p>0.05) on the protein of dry noodles. Treatment with added of anchovies' fish meal concentration of 10% with HMT modification time for 24 hr increased the protein of dry noodles by 8.21%.

Protein of the noodles increased with the addition of anchovy flour. Research by [12] showed that the addition of African catfish meal by 10% had a protein content of 13.37% compared to the control of 9.34%. Protein of dry noodles increased significant different (P<0.05) with fortification of tuna flour [13]. According to [14] the protein content of noodles increased when milkfish flour was added.

The protein of dry noodles with HMT modified sago starch was 10.51% [15]. Research by [4] showed that fortification of fish meals with high protein resulted in an increase in the nutritional value of the protein content of noodle products compared to control noodles. Increasing the nutritional value of food consumed directly or in product form can be enriched by fish protein.

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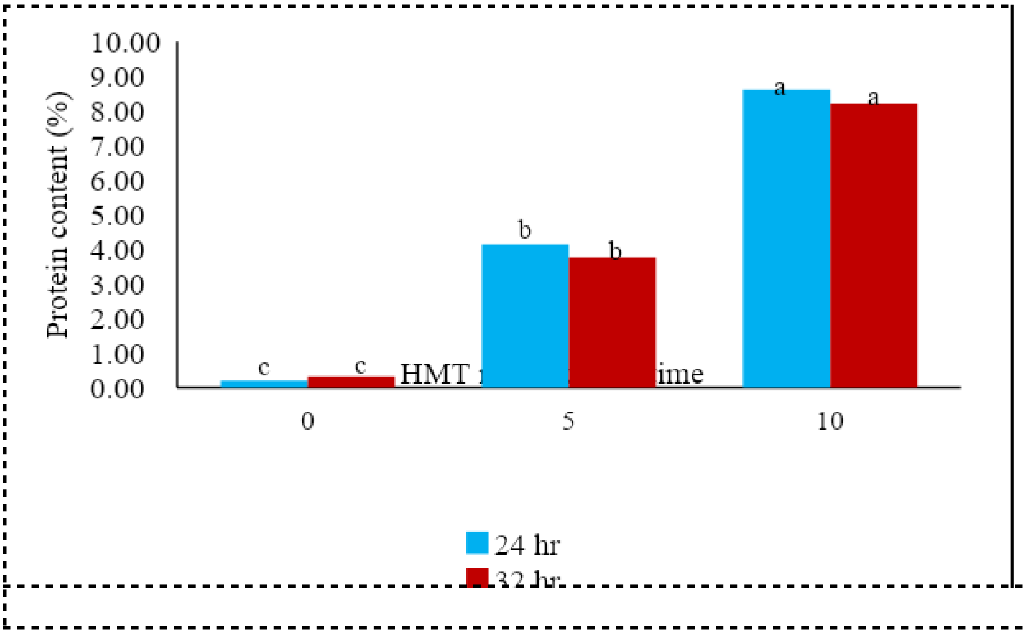

Fig 1. Protein content dry noodles. Treatment with control (0%), and addition of anchovies' fish meal (5% and 10%). Superscripts with different letters [a,b,c] had been significantly different (p<0.05).

3.1.2 Water content

The water content of 12.75-13.82% (Figure 2). There was a very significantly different (P<0.05) between treatment of anchovies' fish meal concentration on the water of dry noodles. Interaction between HMT modification time and anchovies fish meal concentration also had been significant different (P<0.05) on water of dry noodles.

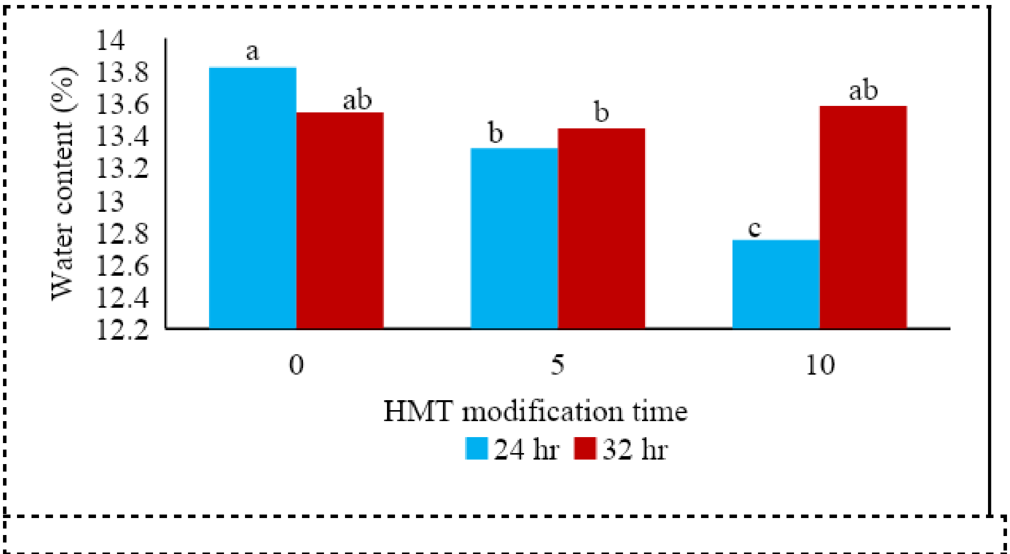

Fig 2. Water content dry noodles. Treatment with control (0%), and addition of anchovies' fish meal (5% and 10%). Superscripts with different letters [a,ab, b,c] had been significantly different (p<0.05).

The difference in water content can be seen when the control dry noodles without anchovy flour is higher than the dry noodles with the added of anchovy flour. Noodles enriched of 10% anchovies fish meal with an HMT modification time of 32 hours had a low water content (12.75%) compared to control noodles and other treated noodles.

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The water of noodles with HMT 20 treatment on sago starch has a low water content of 11.47% [15]. These dry noodles have a lower water content than the research by [16] noodles with the fortification oyster mushrooms (10%) have a water content of 55.96%. According have [17] adding catfish to noodle products has a high-water content (58%). According to [18] the addition of mackerel meal had been significantly different (P<0.05) effect on water content (24.5%) compared to the control.

3.2 Color

The whiteness color of 53.99-60.21% (Figure 3). There was a very significantly different (P<0.05) from the concentration of anchovy flour to the white degree of dry noodles. The interaction between HMT modification time and anchovies fish meal concentration had been significant different (P<0.05) on the whiteness of dry noodles.

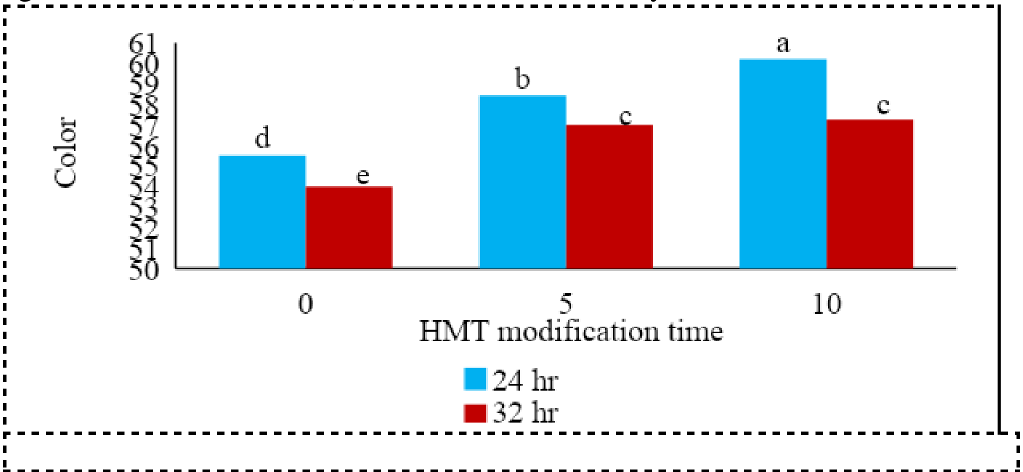

Fig 3. Color dry noodles. Treatment with control (0%), and addition of anchovies' fish meal (5% and 10%). Superscripts with different letters [a, b,c, d,e] had been significantly different (p<0.05.

The color degree of white of noodles shows the highest value with the added of anchovies' fish meal concentration of 10% with an HMT modification time of 24 hr, which was 60.21%. The addition of anchovy flour caused a change in the color of the white degree of the dry noodles. According to [19] the interaction of Beloso fish protein with starch carbohydrates caused the whiteness of the color to increase compared to controls. The protein content of dry noodles increased had been significantly different (p<0.05) with the fortification of skipjack tuna flour [4].

Color measurements showed that as the concentration of anchovy flour increased, the white degree decreased in brightness resulting in a slightly brownish-yellow color. The color of the noodles is getting brownish due to the presence of HMT-modified sago starch [15]. This is thought to be due to the heating process in different sago starch. The brown color of fish meal is caused by non-enzymatic browning, where the proteins and carbohydrates contained in the flour react and produce melanoidin compounds which turn brown, so the fish meal turns brown. The browning produced is due to the browning reaction of lysine which reacts with several reducing sugars at high temperatures.

3.3 Resistant Starch

Dry noodles have resistant starch between 16.84-25.14% (Figure 4). Treatment of anchovies' fish meal concentration had been significantly different ($p<0.05$) on dry noodle-resistant starch, while the interaction between HMT modification time and anchovy meal concentration had been significant different ($p<0.05$) on protein of dry noodles.

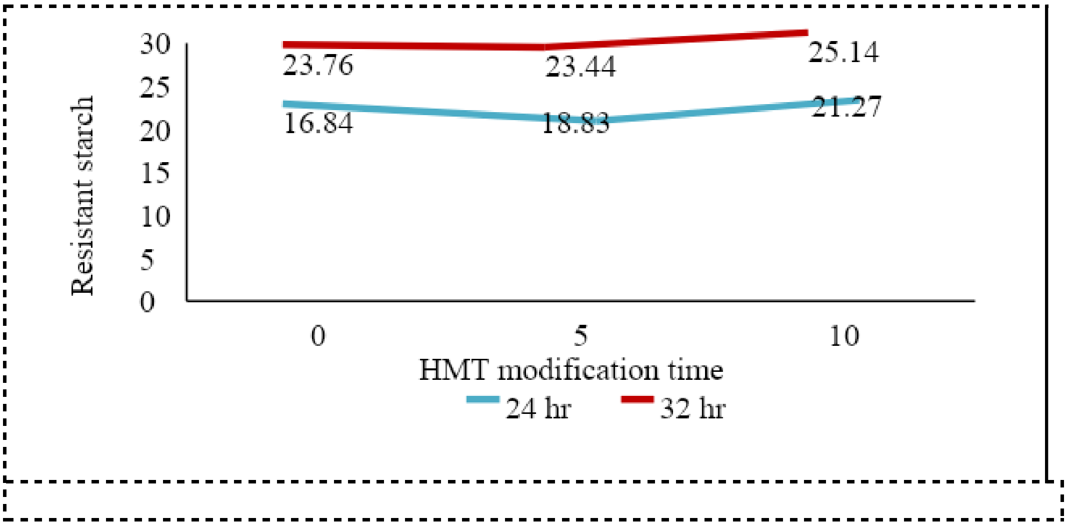

Fig 4. Resistant starch dry noodles. Treatment with control (0%), and addition of anchovies' fish meal (5% and 10%).

The results showed that the longer the HMT modification time and the increased concentration of anchovy flour, the more resistant starch also increased. According to [19], the levels of resistant starch were influenced by the ratio of amylopectin and amylose in starch. Resistant starch levels increase due to higher amylose. The ratio of starch and water can affect resistant starch with a water content of up to 25%, besides that the process of cooling and drying at high temperatures can increase the levels of resistant starch.

Sago starch has an amylose content of 27.4% and amylopectin of 72.6%, while wheat flour has an amylose content is 28% and an amylopectin content is 72%. Sago noodles are included in starch-based noodles because there is resistant starch. The dry noodle-resistant starch from this study was included in the very high category because it was >15%. Sago noodles contain resistant starch of around 45 mg/g. The resistant starch content in sago noodles is 4-5 times greater than the resistant starch content in wheat instant noodles. Resistant starch can be utilized in functional food processing [20].

3.4 Acceptability

The acceptance test is an organoleptic or sensory test to find out if a product is acceptable by using the five human senses based on preferences or desires for a product. The results of preference for dry noodles (Table 1).

Table 1. Acceptance of dry noodles with the addition of anchovies' fish meal[a].

		5.03^{a}	**4.20^{b}**	**4.83^{a}**
24 hr (5%)	**5.03^{a}**	**4.63^{a}**	**5.00^{a}**	**5.00^{a}**
24 hr (10%)		**4.50^{a}**	**4.47^{b}**	**4.77^{a}**
32 hr (0%)	**5.07^{a}**	**4.57^{a}**	**4.40^{b}**	**4.97^{a}**
32 hr (5%)	**4.73^{ab}**	**4.97^{a}**	**5.07^{a}**	**5.27^{a}**
32 hr (10%)	**4.53^{b}**	**3.30^{b}**	**4.20^{b}**	**4.80^{a}**

[a] Superscripts with different letters in the same column had been significant different (p<0.05).

HMT modification time, anchovies fish meal concentration, and the interaction had been significantly different (p<0.05) effect on sensory texture with a panellist's acceptance value of 4.53-5.07. Sensory texture in the HMT modification time treatment of 32 hr without the added of anchovies' fish meal concentration (0%) had a value of 5.07 which means it was liked by the panellists. Treatment for 24 hr HMT modification and 0% anchovies' fish meal concentration, as well as 32 hr HMT modification and anchovies' fish meal concentration with a value of 4.53 which means rather like by the panellists. This study is similar [21], the effect of HMT modification and added catfish on noodle texture, [22] where the acceptance of the texture decreased with the fortification of a nilem flour.

Color has determined the acceptability or preference of a product. The results showed that HMT modification time, anchovies' fish meal concentration, and the interaction of the two treatments had been significant different (P<0.05) effect on color sensory with a panellist acceptance value of 3.30-5.03. Color sensory in the HMT modification time treatment of 32 hr without the addition of anchovy flour concentration (0%) had a value of 5.03 which means it was liked by the panellists. This study is similar [21], the effect of HMT modification and added catfish on noodle color. According to [23], noodles with the addition of green seaweed (20%) have the lowest color value. The high added of skipjack tuna flour causes the color of the noodles to become dark [4].

The results showed that HMT modification time, anchovies fish meal concentration, and the interaction had been significantly different (p<0.05) effect on aroma sensory with a panellist value of 4.20-5.07. Sensory aroma at 32 hr HMT treatment with anchovies' fish meal concentration of 5% had the panellist's preferred value (5.07). HMT modification time of 32 hr with anchovy flour concentration of 10% has a value somewhat favoured by panellists (4.20). This study is similar [21], the effect of HMT modification and added catfish on noodle aroma. These results are consistent with [4] where skipjack flour fortification gives a preferred aroma value. Aroma has a relationship with taste in forming the properties of food.

The sensory value of taste showed that HMT modification time, anchovy meal concentration, and the interaction had not been significantly different (P>0.05) on taste sensory with a panellist value of 4.77-5.27. Taste acceptance by the panellist's had a preferred value (5.27) in the 32-hour HMT modification time treatment with the addition anchovies' fish meal concentration (5%), while the 24-hour HMT modification treatment with anchovies' fish meal concentration of 10% had a value favoured by the panellist's (5.00). This study is similar [21], the no effect of HMT modification and added catfish on noodle taste. This research is in line with the statement of [4] that the noodles with the added of skipjack tuna flour (14%) had a sensory value that the panellists liked the taste, in contrast to [22] where the panellists' taste decreased with the addition of nilem fish flour [23, 24]

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4 Conclusion

The concentration of anchovies' fish meal had been significantly different on protein content, water content, color, and acceptability of dry noodles. Heat Moisture Treatment (HMT) modification duration influenced water content, color, and acceptability, but did not affect protein content. The interaction of anchovies' fish meal with a concentration of 10% and modification time of HMT for 32 hours can increase protein content, and color, and produce highly resistant starch. The resistant starch content in dry noodles was 16.84%-25.14%. Acceptance analysis with anchovies' fish meal concentration for 32 hours of HMT modification yielded the preferred aroma and taste values of 5.07 and 5.27, respectively.

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