Jurnal Peternakan Integratif Vol.9, No. 1, 2021

Jurnal Peternakan Integratif

Nutritional Content of Fermented Kepok Banana Peel (KBP) by Local Microorganisms (MOL)

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Abstract. KBP is a waste from processing of Kepok banana which has not been used optimally because it has low nutritional content. One way to improve nutritional quality of KBP by fermentated process. This study aims to examine the nutritional content of fermented KBP with various doses of MOL and fermentation time. The research was conducted by using an experimental method using a completely randomized design (CRD) with 3 x 3 factorial pattern and 3 replications. The first factor was various doses (D1 = 1%; D2 = 3%; D3 = 5%) and second factor was fermentation time (L1 = 3 days; L2 = 5 days; L3 = 7 days). The variables observed were moisture and dry matter content, crude protein, crude fat, crude fiber, ash, and BETN. The results showed that fermentation of KBP using various doses of MOL had a very significant effect ($P <0.01$) on moisture content, dry matter, crude protein, ash, but had no significant effect ($P> 0.05$) on crude fiber, crude fat and BETN. Fermentation time had no significant effect ($P> 0.05$) on moisture content, dry matter, crude protein, crude fiber, crude fat, and BETN, but had a very significant effect ($P <0.01$) on ash content. There was an interaction between MOL dose and fermentation time on BETN levels but there was no interaction between MOL dose and fermentation time on moisture content, dry matter, crude protein, crude fiber, crude fat and ash. The conclusion of this research is fermentation of KBP using MOL up to 5% increased dry matter content, crude protein, and decreased moisture content and ash content.

Keywords: fermentation, kepok banana peel, MOL, nutritional content

Received [17 February 2021] | Revised [27 February 2021] | Accepted [19 March 2021]

1. Introduction

KBP is a waste from the processing of Kepok banana which has not been used optimally. Total banana production in Indonesia reached 6,279,290 tons with banana production in North Sumatra province in 2013 reaching 342,298 tons in total [1]. The protein content in KBP is relatively low and high crude fiber caused low digestibility of the banana peel and becomes an obstacle in the use of the banana peel as a feed that can meetthe nutritional needs of livestock. To increase crude protein and reduce crude fiber can be done by processing technology, one of which is the fermentation process. Local Microorganisms (MOL) can be used as a starter in fermentation. Microbes derived fromthe substrate themselves have a high ability to degredate the substrate [2].

One of the most costly production factors is feed. An important part of the feed factor is the quality and effectiveness of feeding. So far, most breeders provide feed in wet form. This wet feed does not last long, so at every feeding, the feed must run out quickly. Because wet feed doesn't last long, it's easier for mushrooms to grow. As a way out of this problem, fermentation technology can be used. Fermentation is the process of breaking down organic compounds into simpler compounds by involving the role of microorganisms [3]. This study aims to determine the effect of MOL dose and fermentation time on the nutritional content of KBP.

2. Materials and Methods

2.1. Materials

The materials used in this study were KBP flour, rice bran, molasses, MOL based on kepok banana peel. In making MOL, a process of fermentation by using rice washing water, brown sugar, molasses, coconut water as a source of glucose, urea as a source of additional nutrition for microbes, rice bran as a source of carbohydrates. and KBP, than fermented for thirty days.

2.2. Methods

The research design used a completely randomized design (CRD) with 2 factors (3x3) each repeated 3 times, so that 27 research units were obtained.

Factor I: dose of use of Mol (D)

solutionD1 = 1%

D2 = 3%

D3 = 5%

Second factor: Fermentation time of KBP

(L)L1 = 3 days

L2 = 5

days

L3 = 7

days

The parameters observed in this study were moisture content, dry matter, crude protein, rude fat, crude fiber, ash content, and extracts without nitrogen (BETN). If the results of the diversity analysis show differences, further testing will be carried out using the Duncan method.

3. Result and Discussion

3.1. Local Microorganisms (MOL)

Local microorganisms organoleptic observation of KBP can be seen in “Table 1”.

Table 1. The organoleptic observation of kepok MOL

Parameters	Results
Color	murkyYellow
Aroma / Smell	Acid / Tapai
Viscosity	Watery
pH	3.5
Total Acid Titrated	0.36%

“Table 1” shows that the MOL of KBP has an effect on color, aroma, thickness, pH, total titrated acid and fungi. In a good fermentation process there will be changes in pH, aroma, texture, and color [4]. Physical changes such as odor, color, and texture indicate that there is a microbial process and a degradation process of crude fiber by the microorganisms in it which changes the texture that is difficult to digest into easier to digest [5].

3.2. Water Content and Dry Matter

The results of the analysis of water content of KBP flour with MOL doses of 1, 3, 5% and fermentation time of 3, 5 and 7 days are presented in “Table 2”.

Table 2. Water content of fermented KBP by MOL (%)

MOL dose (D)	Old fermentation (L)			Average
	L_1 (3 days)	L_2 (5 days)	L_3 (7 days)	
D_1 (1%)	6.13	6.00	5.87	6.00^{B}
D_2 (3%)	6.26	6.46	6.25	6.32^{C}
D_3 (5%)	5.73	5.59	5.66	5.6^{A}
Average	6.04^{tn}	6.02^{tn}	5.33^{tn}	

Note: Different superscripts in the same column show very significant differences(P<0.01). The same superscript on the same line shows no significant effect (P> 0.05).

The water content of KBP flour fermented by MOL at various doses and fermentation time ranged from 5.66 to 6.32%, a decrease compared to before fermentation (control), which was 8.41%. The fermentation process causes a decrease in water content compared to before fermentation. This happens because of the activity of microorganisms that play a role in the fermentation process to break down complex compounds more simply to produce residual products in the form of water. Microbes in carrying out the carbohydrate metabolism process produce water as a by product [6]. If in the fermentation process other dry ingredients are added, it will also increase the percentage of dry matter content so that the percentage of water content in the material will decrease. The decrease in water content also has an effect on the increase in the value of the dry matter content of the material [7].

From the analysis of diversity it was shown that the MOL dosehave a very significant effect (P <0.01) on changes in water content in fermented KBP. However, the fermentation time did not significantly affect changes in the moisture content of the KBP. There was no interaction between MOL dose and fermentation time on water content. Based on the results of continued test, the *Duncan's mean range test* (DMRT),it was found that there was a decrease in the water content of fermented KBP. The higher the MOL in fermentation, the lower the water content that occurs due to thewater component that is wasted during the overhaul of organic compounds due to microbial activity. The longer the fermentation process also causes the starch source to be less integrated so that the water holding capacity in the material decreases. [8].

The results of the analysis of the dry matter of KBP flour with MOL doses of 1, 3, 5% and fermentation time of 3, 5 and 7 days are presented in "Table 3".

Table 3. The dry matter content of fermented KBP by MOL (%)

MOL dosage(D)	Duration of fermentation (L)			Average
	L_1 (3 days)	L_2 (5 days)	L_3 (7 days)	
D_1 (1%)	93.87	94.00	94.19	94.00^{B}
D_2 (3%)	94.74	93.54	94.75	93.68^{A}
D_3 (5%)	94.27	94.41	94.34	94.34^{C}
average	93.96^{tn}	93.98^{tn}	94.07^{tn}	

Note: Different superscripts in the same column show very significant differences(P<0.01).
The same superscript on the same line shows no significant effect (P> 0.05).

There was an increase in the dry matter content of the fermented KBP to 93.54 - 94.75%, higher than before fermentation, namely 91.58%. The results of the analysis of diversity indicated that the dose of MOL had a very significant effect (P <0.01) on changes in the dry matter content of fermented KBP. However, the duration of fermentation has no significant effect on the dry matter of the banana peel and there is no interaction between the two factors. Based on the results of continued test *Duncan's mean range test* (DMRT), it was found that there was an increase in the dry matter content of fermented KBP.

The high dry matter content is due to the more inoculum added so that microbial activity increases. The multiplication of mycelium from microbes as an indicator of microbial growth in the fermentation process can cause an increase in dry matter content [9]. The high dry matter content in the material added to the substrate will affect the dry matter content of the material. [10].

3.3. Crude Protein

The results of the analysis of crude protein content of fermented KBP by MOL dose of 1, 3, 5% and fermentation time of 3, 5, 7 days are presented in "Table 4".

Table 4. Crude protein content of fermented KBP by MOL (%)

Dosage of MOL (D)	Duration of fermentation (L)			Average
	L_1 (3 days)	L_2 (5 days)	L_3 (7 days)	
D_1 (1%)	8.50	9.37	9.08	8.99^A
D_2 (3%)	9.38	11.14	11.43	10.65^B
D_3 (5%)	13.77	13.48	10.84	12.70^C
Average	10.55^{tn}	11.33^{tn}	10.45^{tn}	

Note: Different superscripts in the same column show very significant differences(P<0.01). The same superscript on the same line shows no significant effect (P> 0.05).

KBP fermented using MOL with various doses and fermentation time experienced changes ranging from 8.50 - 13.77%, and non-fermented with crude protein content of 5.27%. The results showed that the MOL dose had a very significant effect (P<0.01) on changes in the crude protein content of fermented KBP. However, the fermentation time did not significantly affect changes in protein content and there was no interaction between the two factors.

The high increase in crude protein is due to the presence of microorganisms that produce cellulase and protease enzymes that can break protein bonds. In addition, the increase in crude protein is due to single cell proteins from microorganisms that develop during the fermentation process. [11].

3.4. Crude Fiber

The results of the analysis of crude fiber content of fermented KBP by MOL dose of 1, 3, 5% and fermentation time of 3, 5, 7 days are presented in "Table 5".

Table 5. Crude fiber content of fermented KBP by MOL (%)

MOL dose(D)	Duration of fermentation (L)			Average
	L_1 (3 days)	L_2 (5 days)	L_3 (7 days)	
D_1 (1%)	16.85	17.22	16.40	16.83
D_2 (3%)	15.85	15.88	16.48	16.07
D_3 (5%)	17.09	17.29	15.73	16.71
Average	16.60	16.80	16.21	

Note: The same superscript in different rows and columns shows no significant effect (P>0.05).

The results of the fermentation of KBP, there was a change in crude fiber content using MOL with different doses and different fermentation times ranging from 15.73% - 17.29%, lower than the unfermented KBP of 17.74%. The results of the analysis of diversity indicated that the MOL dose and fermentation time had no significant effect on reducing crude fiber content in fermented KBP. From the results of the analysis of diversity it is also shown that there is no interaction between the two factors.

The higher MOL dosage and fermentation time treatment in the study did not show any effect on decreasing crude fiber content. This is presumably due to theamount of mold contained in the KBP which inhibits the work of microbes in decreasing the crude fiber of KBP. Fungi have the potential to produce cellobiohydrolase enzymes, and these enzymes will degredate cellulose into cellobiose as the only product of hydrolysis. The result of accumulation of cellobiose in thesubstrate can inhibit the action of the enzyme.

3.5. Crude Fat

The results of the analysis of crude fat content of fermented KBP with MOL doses of 1, 3, 5% and fermentation time of 3, 5, 7 days are presented in "Table 6".

Table 6. Crude fat content of fermented KBP by MOL(%)

MOL (D)	Time of fermentation (L)			Average
	L_1 (3 days)	L_2 (5 days)	L_3 (7 days)	
D_1 (1%)	14.11	13.60	13.47	13.73
D_2 (3%)	14.43	13.49	16.48	14.80
D_3 (5%)	14.78	15.19	14.66	14.88
Average	14.44	14.09	14.87	

Note: The same superscript in different rows and columns shows no significant effect (P>0.05).

The use of MOL at various doses and fermentation time for KBP crude fat obtained results ranging from 13.47 to 16.48%, while the crude fat content before fermentation (control) was 11.54%. The results of the analysis of diversity showed that the MOL dose of fermentation and fermentation time did not have a significant effect (P> 0.05) on crude fat from fermentation of the KBP From the results of the analysis of diversity it is also shown that there is no interaction between the two factors.Giving different MOL doses and fermentation time did not show a significant effect on reducing the crude fat content of fermented KBP. This is presumably due to the development of fat degrading microbes from fermented KBP that are not well developed. Changes in the crude fat content of fermented KBP were not significant because the microbes that play a role in producing enzyme *lipase* have not reached themaximum phase so they do not play a role in breaking down the fat [8].

3.6. Ash Content

The results of the analysis of the ash content of fermented KBP by MOL dosesof 1, 3, 5% and fermentation time of 3, 5, 7 days can be seen in "Table 7" below.

Table 7. Ash content of fermented KBP by MOL (%)

MOL dose(D)	Time of fermentation (L)			
		AverageL_1 (3 days) L_2 (5 days)		L_3
	(7 days)			
D_1 (1%)	21.06	18.96	20.37	20.13^{B}
D_2 (3%)	21.44	18.87	20.60	20.30^{B}
D_3 (5%)	17.78	17.16	17.17	17.37^{A}
Average	20.09^{b}	18.33^{a}	19.38^{b}	

Note: Different superscripts in the same row and column show very significantdifferences (P <0.01).

The difference in MOL dosage and fermentation time for KBP changes in fluctuating ash content after fermentation. The decrease in ash content after fermentation reached 17.16% and the ash content before fermentation was 19.24%. The results of the analysis of diversity showed that the MOL dose and fermentation time hada very significant effect (P <0.01) on changes in the ash content of fermented KBP. However, the results of the analysis of diversity also indicated that there was no interaction between the MOL dose and the fermentation time.The decreased ash contentwas due to an increase in organic matter of the process degredation of the material (substrate) by microbes. The less organic matter is degredated, the less there will be a decrease in the ash content proportionately, conversely, the more organic matter is degredated, the more there will be a proportionate increase in ash content [12].

3.7. Nitrogen-Free Extract (BETN)

The results of the analysis of BETN levels in fermented KBP with a MOL dose of 1, 3.5% and fermentation time of 3.5, 7 days are presented in "Table 8".

Table 8. BETN levels of fermented KBP by MOL(%)

MOL dose(D)	long fermentation (L)			Average
	L_1 (3 days)	L_2 (5 days)	L_3 (7 days)	
D_1 (1%)	39.48^{Cc}	40.85^{Cb}	40.67^{abC}	40.33
D_2 (3%)	38.90^{Bc}	40.62^{Cc}	35.01^{Aab}	38.18
D_3 (5%)	36.57^{ABc}	36.88^{Ca}	41.59^{Cc}	38.35
Average	38.32	39, 45	39.09	

Note: Different superscripts in the same row and column show significant differences (P<0.05).
The uppercase notation indicates the MOL dose, the lowercase notation indicates the fermentation time.

KBP fermented by MOL with various doses and length of fermentation changes ranged BETN 35.01% - 41.59%, lower than the banana peel kepok unfermented (control) of 46.21%. The results of the analysis of diversity showed that the MOL dose and fermentation time had no significant effect (P> 0.05) on changes in BETN in fermented KBP. However, the interaction between the two factors on the BETN level of fermented kepok banana peels showed a significant effect (P <0.05).The BETN content tends to decrease because the BETN is used as energy by microbes in their growth. In their activity, microbes use an energy source of easily digested carbohydrates (BETN) as the first step for growth and reproduction. An increase in microbial activity indegrading the substrate will also affect the use of energy (BETN) which is increasing too, so that high microbial activity can reduce the BETN content [13].

3.8. Recapitulation of Research Results

Based on the results of the study, it was found that the fermentation of KBP by various MOL dosage treatments and fermentation time had an effect on moisture content, dry matter, crude fat, crude protein, crude fiber, ash, and BETN. The interaction between MOL dose and duration of fermentation of KBP on nutritional content is presented in "Table 9".

Table 9. Interaction of dose and duration of fermentation on nutritional content of KBP

Treatment	Water (%)	Dry matter (%)	Protein (%)	Crude fiber (%)	Fat (%)	Ash (%)	BETN (%)
D1L1	6.13^{tn}	93.87^{tn}	8.50^{tn}	16.85^{tn}	14.11^{tn}	21.06^{tn}	39.48^{Cc}
D2L2	6.00^{tn}	94.00^{tn}	9,37^{tn}	17,22^{tn}	13,60^{tn}	18,96^{tn}	40,85^{cb}
D3L3	5.87^{tn}	94.19^{tn}	9.08^{tn}	16.40^{tn}	13, 4^{tn}	20.37^{tn}	40.67^{abC}
D1L1	6.26^{tn}	94.74^{tn}	9.38^{tn}	15.85^{tn}	14.43^{tn}	21.44^{tn}	38.90^{Bb}
D2L2	6.46^{tn}	93.54^{tn}	11.14^{tn}	15.88^{tn}	13.49^{tn}	18.87^{tn}	40.62^{Cc}
D3L3	6.25^{tn}	94.75^{tn}	11.43^{tn}	16.48^{tn}	16.48^{tn}	20, 60^{tn}	35.01^{Aab}
D1L1	5.73^{tn}	94.27^{tn}	13.77^{tn}	17.09^{tn}	14.78^{tn}	17.78^{tn}	36.57^{Abc}
D2L2	5.59^{tn}	94.41^{tn}	13.48^{tn}	17.29^{tn}	15.19^{tn}	17.16^{tn}	36.88^{Ca}
D3L3	5.66^{tn}	94.34^{tn}	10.84^{tn}	15.73^{tn}	14.66^{tn}	17.17^{tn}	41,59^{Cc}

4. Conclusion

Based on the results of the study, it was found that the dosage of using MOL up to 5% of the weight of KBP increased dry matter content, crude protein, reduce the moisture content of fiber, ash content, and can reduce water content, crude fiber.Fermentation time starting from day three affected the ash content, and there was an interaction between MOL dose and fermentation time on BETN.

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