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RESEARCH ARTICLE

NUTRITIVE EVALUATION OF CORN STRAW FERMENTED BY TRICHODERMA VIRIDE AS CROSS BREED CHICKEN FEED STUFF IN GORONTALO REGENCY.

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Abstract

This study aims to evaluate the nutritional content of corn straw through BK, BO, PK, SK, LK, ash, BETN, cellulose, hemicellulose and lignin and select the fermented corn straw with *Trichoderma viride* as the best feed ingredients. Corn straw (leaves) obtained from local farmers to be fermented chopped with a size of ± 1-3 cm as much as 1 kg then sprayed with water to 55-60% humidity, then sprinkled with 7% *Trichoderma viride* inoculum until evenly distributed. Furthermore, corn straw was put into a plastic bag that is given small holes and then incubated for 1, 2 and 3 weeks. After the plastic is opened, samples are taken to analyze the nutrient content. This study used a completely randomized design (CRD) with four treatments and four replications. The four treatments are R0 = unfermented corn straw; R1 = fermented corn straw with an incubation period of 1 week; R2 = fermented corn straw with an incubation period of 2 weeks; R3 = fermented corn straw with an incubation period of 3 weeks. Variables measured were dry matter (BK), organic matter (BO), crude protein (PK), crude fiber (SK), crude fat (LK), ash, BETN, cellulose, hemicellulose and lignin. The results showed that the fermentation of corn straw in treatment R2, which named the fermentation of corn straw with an incubation period of 2 weeks showed the best nutritional quality compared to other treatments. Corn straw in Gorontalo regency after fermentation has better nutritional content and can be used in the formulation of cross breed chicken rations.

Introduction:-

The production of corn waste every year continues to increase quite significantly along with the increase in production of these agricultural crops. With the availability of corn straw is potential and provides opportunities to be used as animal feed. Gorontalo Regency BPS data (2017) shows that corn production in 2016 produced 307,000 tons of dry shelled rose to 478,786 tons in 2017 which increase 50%. Corn planting area reaches 107,000 hectares. The potential of this large amount of corn straw can be utilized as an alternative feed material, because the potential of local feed ingredients has the prospect of high availability at a relatively cheap price. But the composition of the food substances it contains can compete with conventional feed ingredients. On the other hand conventional feed is faced with dependence on imported raw materials. Limitations of conventional feed sources can be overcome by using feed ingredients based on by products produced by corn.

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It is the time for the development of cross breed chicken in Gorontalo regency to be integrated with existing food sources in the area, so efforts should be made to utilize agricultural waste. Agricultural food waste such as corn straw, peanut straw, rice straw and etc. are quite abundant (BPS of Gorontalo Regency, 2017).

Corn straw is an alternative feed ingredient that can be given to super native chickens. Availability and limitations in the use of alternative feed raw materials are less guaranteed, the crude fiber content is quite high. This is caused by a lignification that is the formation of complex compounds called *lignocellulose and lignohemicellulose* (Suparjo, 2010). Corn straw has 6.38% crude protein content, 30.19% crude fiber, 2.81% crude fat, 51.69% BETN, 8.94% ash and 53.12% TDN content (Bahar, 2016)). According to Oseni and Esperigin (2007) the nutritional content of corn straw is crude protein 5.51%, crude fiber 35.72%, crude fat 6.04% and ash 1.82%, while according to the results of the laboratory analysis of Animal Food Chemistry, Faculty of Animal Husbandry, Hasanuddin University of Makasar (2017) for 90-day-old corn straw has a content for crude protein 6.53% crude fiber 34.08%, crude fat 1.68%, BETN 45.05%, ash 12.66%. Based on the analysis of these nutrients, corn straw can be used as a basic ingredient in poultry ration formulations.

Corn straw contains cellulose and hemicellulose which is quite high. The high cellulose content has the potential to be used as raw material for animal feed. However, like other raw materials containing lignocellulose, the use of corn straw requires treatment to release the bonds between the components of lignocellulose. One way to do this is by biological means by utilizing molds that produce cellulose enzymes, converting cellulose into simple sugars such as glucose (Chetan et al., 2014). The use of corn straw directly or as feed cannot meet the intake in accordance with the needs of livestock. Increasing the production and quality of super chicken meat will be done by providing feed with the addition of corn straw which has been fermented beforehand with the help of microorganisms. It is expected that this fermentation is an alternative to increase the optimal nutritional value and organic matter from corn straw.

This research uses Trichoderma viride. The use of mold was based on several studies including Trichoderma viride able to hydrolyze cellulose to simple sugar (glucose) by 12% on rice straw substrate after fermentation for 6 days (Sari Mustika et al., 2008). In addition Trichoderma viride is a member of the Trichoderma genus which produces extracellular enzymes in high amounts so that it is widely applied in biotechnology (Gupta et al., 2014). With the advantages of these molds, in this study the use of molds was tested on corn straw.

Based on these reasons, research will be conducted on the use of *Trichoderma viride* in improving the quality of corn straw into products that have added value as raw material for animal feed. Thus the information data on the nutritional content of corn straw as feed raw material can be used as a reference in planning the development of cross breed chickens in Gorontalo regency by utilizing corn waste and coping with increased production by efficient feed costs.

Research purposes:-

This study aims to evaluate the nutritional content of corn straw through BK, BO, PK, SK, LK, ash, BETN, cellulose, hemicellulose and lignin and select the fermented corn straw with *Trichoderma viride* as the best feed ingredients.

Research Methods:-

Materials and methods:-

The materials used in the corn straw fermentation are; corn straw, Trichoderma viride mold. While the tools used are chopper for cutting straw, tarpaulin for mixing straw, plastic bags as straw wrappers.

Place and Duration of Research:-

This research was conducted in the laboratory of animal husbandry at the Faculty of Agriculture, Gorontalo State University for 3 weeks.

Making fermented corn straw:-

Corn straw (leaves) obtained from local farmers that will be fermented is chopped with a size of ± 1-3 cm as much as 1 kg then sprayed with water to 55-60% humidity, then sprinkled 7% (Rizal et al., 2012) inoculum fungi Trichoderma viride until evenly distributed. Then put in a plastic bag that was given small holes and then incubated for 1, 2 and 3 weeks. After enough time the plastic is opened, samples are taken for laboratory analysis.

Experimental design:-
The design used in this study was a completely randomized design (CRD) with 4 treatments and 4 replications, so that there were 16 experimental units. The four treatments were R0 = unfermented corn straw; R1 = fermented corn straw with an incubation period of 1 week; R2 = fermented corn straw with an incubation period of 2 weeks; R3 = fermented corn straw with an incubation period of 3 weeks.

Observed variables:-
The variables observed in this study were dry matter (BK), organic matter (BO), crude protein (PK), crude fiber (SK), crude fat (LK), ash, BETN, cellulose, hemicellulose and lignin.

Statistical analysis:-
Data obtained in this study were analyzed using variance, if there were significant differences in the mean values of the treatment followed by the Duncan test (Steel and Torrie 1997).

Research Result And Discussion:-

The content of BK, BO, PK, LK, SK, Ash and BETN fermented corn straw:-

Table 1:- Content of Dried Ingredients (BK), Organic Ingredients (BO), Crude Protein (PK), Crude Fat (LK), Crude Fiber (SK), Ash and BETN fermented corn straw Trichoderma viride with different incubation times

Variable	Treatment[1)]			
	RO	R1	R2	R3
(BK) (%)	88.49±0,14[a]	86.46±0,33[b]	79.49±0.11[d]	85.36±0,16[c]
(BO) (%)	74.75±1,42[a]	69.84±0,61[b]	60.02±0,49[d]	68.30±0,30[c]
(PK) (%)	11.32±0,25[b]	10.28±0,27[c]	12.63±0,60[a]	10.84±0,35[bc]
(LK) (%)	1.95±0,12[b]	2.50±0,04[a]	2.78±0,09[a]	2.09±0,39[b]
(SK) (%)	29.12±0,47[a]	27.03±0,44[b]	24.17±0,65[d]	25.12±0,08[c]
Ash (%)	14.52±0,20[c]	16.62±0,33[b]	19.47±0,59[a]	17.06±0,14[b]
BETN (%)	43.12±0,88[b]	43.58±0,80[b]	40.95±0,49[c]	44.90±0,23[a]

Details :
1. R0 = ration without fermentation treatment; R1 = rations treated with fermented straw treated incubated for 1 week; R2 = ration with fermented straw treatment incubated for 2 weeks; R3 = rations with fermented straw treatment incubated for 3 weeks;
2. Different letters on the same line show very significant differences ($P < 0.01$)

Corn straw fermentation using trichoderma viride with an incubation period of 2 weeks tends to reduce dry matter (table 1). The dry matter in P2 treatment was 79.49% and significantly lower compared to the P0, P1 and P3 treatments respectively 88.49%, 86.46%, and 85.36%. The content of dry matter in feed ingredients without treatment (R0) is 88.49% and significantly higher compared to treatments P1, P2 and P3 due to the treatment of R0 without inoculants, there are no microorganisms that degrade so dry matter tends to be higher. Duncan's test showed that in P2 treatment with a 2-week incubation duration the dry matter content was significantly lower than the incubation period of 1 week and 3 weeks. Ginting and Krisnan (2006) state that the decrease in dry matter content indicates that the fermentation process has been going well. The fermentation process occurs through a series of biochemical reactions that convert dry matter into energy (heat), water molecules (H2O) and CO2, this process causes a decrease in the level of dry matter substrate used. At the time of fermentation there are microorganisms that degrade dry matter so that dry matter tends to be lower. Syahrir et al. (2014) states that the reduction of dry matter after fermentation (grams) with dry matter before fermentation (grams) is caused by the fermentation process which has the effect of decomposition or addition of nutrients in the fermentation media. The decrease in dry matter in P2 is thought to be caused by Trichoderma viride starting to synthesize the decomposing enzyme, cellulose which will overhaul the cellulose in the product. Besides the decrease in dry matter after fermentation is caused during the fermentation process also takes place a respiration process, where in this process besides producing energy also produced water and CO2. Partially produced water will be left in the product and partly out of the product. Water left behind is what will cause the water content to be high and dry ingredients tend to be low.

The results of analysis of variance showed that corn straw inoculated with Trichoderma viride with different curing times showed very significant differences (P <0.01) to the organic matter of corn straw. The duncan test shows that the organic matter content in the P0 treatment was higher than the other treatments. P1 treatment was higher than P3 treatment, P3 treatment was higher than P2 treatment (table 1). This decrease in organic material during the incubation period of 2 weeks is probably caused by the activity of microorganisms contained in straw so that the fermentation process causes the breakdown of complex compounds to be simple and makes it easier for microorganisms to digest organic matter and fermentation results such as fatty acids and alcohol that are lost during fermentation which is due to the heat generated. Wilkinson, (1988) states that the fermentation process can affect changes in nutritional value, namely carbohydrates can be converted into alcohol, organic acids, water and carbon dioxide. This follows the tendency that if the dry matter content is high then the organic material is also high and vice versa if the dry matter content is low then the organic material content also decreases. Organic matter is part of dry matter, so the higher the consumption of dry matter, the consumption of organic material tends to increase. Tilman et al. (1998) states that organic matter is the largest portion of dry matter, so increasing dry matter increases organic matter.

Table 1 shows that in the P2 treatment the average crude protein was higher and significantly different (P <0.01). The treatment of corn straw fermentation with Trichoderma viride inoculant was significantly (P <0.01) affected crude protein content. Before fermentation, the protein content of cornstarch leaves was 11.32% and after fermentation there was an increase in P2 treatment for a 2-week ripening period of 12.63%. The Duncan test results showed that the treatment that produced the highest crude protein content was in P2 treatment. The P0 treatment is the same as the P3 treatment, P3 treatment is the same as the P0 treatment (table 1). The increase in crude protein content in the incubation period of 2 weeks is likely caused by the formation of fermentation products or due to microbial growth in the fermentation media, resulting in an increase in Trichoderma cell mass as a result of microbial biomass will increase. Increased microbial biomass will increase the nutrient content, especially protein derived from microbial biomass. This is in line with the statement of Ginting and Krisnan (2006) that to achieve the highest protein content, Trichoderma viride requires an incubation period of 15 days. Hartadi et al (1984) stated that the development of Trichoderma will form mycelium by utilizing NH3 and carbon substrate sources, so that it will automatically increase protein levels in line with the increase in storage time in the biodegradation process. The research results of Ahmad et al. (2015) using Trichoderma sp. in oil palm fronds that in the fermentation process there is a tendency for an increase in crude protein levels ranging from 0-12 week long storage.

The P2 treatment showed the highest crude fat content (P <0.01) higher than the other treatments (table 1). The Duncan test showed that the P1 treatment was the same as P2 but there was a tendency for an increase in the crude fat content of corn straw at 2 weeks incubation time. This is due to the incubation duration of 2 weeks, the ability of Trichoderma viride fungi can break down the fat used as nutrition in its growth. The degradation process occurs in organic matter which is utilized by bacteria to form fat so that the crude fat content in the fermented corn straw increases. Irma et al (2012) research results that Trichoderma viride fermentation in corn flour has an increase in fat which is suspected because mold can convert carbohydrates in the media / substrate into fat which is then accumulated as cell fat. Soeparno (2009) states that in the fermentation process bacterial activity can produce high fatty acids so that the fat content produced tends to increase.

The crude fiber content decreased at P2 treatment that was 24.15%. Compared to P0 29.12%, P1 27.03% and P3 by 25.12% (table 1). This indicates that at 2 weeks incubation there was high competition by microbes in utilizing crude fiber substrate for microbial metabolic processes. Microbes will break down crude fibers when the microbes already produce enzymes by utilizing nutrients contained in the substrate. Narasimha, (2006) states that with increasing fermentation time the enzyme activity will increase following the growth patterns of microorganisms that experience several growth phases, namely the adaptation phase, exponential phase, stationary phase, and death phase. This can be suspected when the enzyme activity produced is high, then mold has been in that phase. The results of Ginting and Krisnan's research (2006) on palm kernel cake fermentation using several Trichoderma strains decreased crude fiber content (P <0.05), and the lowest fermentation time was 6-15 days and an increase in crude fiber fermentation time above 15 day. The longer incubation period causes an increase in the crude fiber content in the substrate. This is thought to be caused by a decrease in the water content of the substrate, so that the coarse fiber is more concentrated. Therefore, the incubation period of 2 weeks can be considered as the optimal incubation period.

The highest ash content in the 2-week incubation treatment was 19.47% while the P0, P1 and P3 treatments were respectively 14.52%, 16.62%, and 17.06% very significantly (P <0.01) lower . Ash content increased during the incubation period of 2 weeks, this is due to the loss of organic matter in the fermentation of 2 weeks. This is supported by the statement of Omer et.al. (2012) that maize straw inoculated with Trichoderma ressei increased crude protein and ash content while NDF, ADF, ADL and hemicellulose content decreased.

The BETN content of fermented corn straw decreased in the P2 treatment for 2 weeks incubation period. In this study the increase in protein in the treatment of the 2-week incubation period was followed by a decrease in BETN and crude fiber. Moore's (2003) statement that carbohydrates (BETN and crude fiber) contained in food is used by molds as an energy source for growth so that the BETN content decreases. Oboh, 2006 states that in its growth molds are able to hydrolyze starch to glucose as a carbon source for growth.

Ingredients Cellulose, Hemicellulose and Lignin Fermented Corn Straw

Table 2:-Cellulose, Hemicellulose and Lignin content of Fermented Corn straw

Variable	Treatment [1)]			
	RO	R1	R2	R3
Cellulose (%)	32,96[b]	32,93[b]	32,48[b]	34,55[a]
Hemicellulose (%)	22,59[a]	15,30[b]	11,78[c]	12,27[c]
Lignin (%)	10,60[a]	11,15[a]	8,57[b]	10,55[a]

Details:

1. R0 = ration without fermentation treatment; R1 = rations treated with fermented straw treated incubated for 1 week; R2 = ration with fermented straw treatment incubated for 2 weeks; R3 = rations with fermented straw treatment incubated for 3 weeks;
2. Different letters on the same line show significant differences (P <0.05)

Table 2 shows that the cellulose content of maize straw fermented by Trichoderma viride between treatments showed significant differences (P <0.05) ranging from 32.48% - 34.55%. In P2 treatment, the cellulose content was lower compared to other treatments, namely 32.48%, followed by P1 (32.93%), P0 (32.97%), and P3 (34.55%). P2 treatment (with 2 weeks fermentation time) showed the lowest cellulose content compared to other treatments. The low cellulose content is caused by the presence of fiber digesting enzymes. Fiber digestive enzymes function to degrade coarse fiber during the fermentation process. This is supported by Wiharsono, et al (2005) who states that the cellulose enzyme is one of the enzymes produced by microorganisms that function to degrade cellulose to glucose. Tribak et al., (2002) state that the superiority of Trichoderma viride molds in addition to producing cellulose enzymes also produces xyloglucolytic enzymes, where this enzyme makes it easier for cellulose to break down cellulose.

The content of hemicellulose fermented corn straw Trichoderma viride with different curing times based on analysis of diversity from the research data showed very significant differences (P <0.01). Curing duration of 2 weeks (P2) shows a low hemicellulose content of 11, 78% followed by P3 treatment (curing duration of 3 weeks) 12.27% then P1 (duration of curing for 1 week) 15.30% then P0 (without treatment) 22.59%. Changes in hemicellulose content can occur during the fermentation process due to the presence of fiber digesting enzymes. The longer the fermentation time the hemicellulose degradation rate is getting faster. The fermentation time of 2 weeks was significantly different (P <0.01) with the fermentation time of 1 and 3 weeks for the degradation rate of hemicellulose corn straw. The high degradation rate at the 2-week fermentation treatment was also partly due to the low lignin content. Omer et.al. (2012) states that corn straw inoculated with Trichoderma ressei can reduce the content of NDF, ADF, ADL and hemicellulose. Furthermore, Reksohadiprodjo (1988) added that the low content of hemicellulose was caused by hemicellulose being broken down into pentose sugar during the fermentation process. The split hemicellulose causes the hemicellulose content after fermentation to decrease. Hemicellulose is a constituent of cell walls which has a low solubility level (Broz and Ward, 2007).

The results of the average fermented corn straw lignin content using Trichoderma viride mold can be seen in table 2. The fermentation time of 1, 2 and 3 weeks showed a significant difference (P> 0.05). Incubation time of 2 weeks produces low lignin content. This is closely related to the time spent by molds for growth and propagation. With the long fermentation time means mold continues to grow and reproduce until the stationary phase is reached. Molds during growth and development are thought to keep using soluble components while cell walls continue to accumulate in the product. The difference in lignin content in the difference in incubation time has to do with the time spent by molds for growth and propagation. Extending the fermentation time means that mold continues to grow and multiply and produce fiber-breaking enzymes, namely cellulose enzymes so that the lignin content is lower. Decrease in fiber fraction in fermented corn straw is caused by increased activity of cellulose enzymes produced by molds in remodel, degrade, loosen and break lignocellulose and lignohemicellulose bonds. This shows that the activity of cellulose enzymes that degrade cellulose is highest at the incubation period of 2 weeks.

Conclusions:-

1. Corn straw fermentation using Trichoderma viride mold with 2 weeks incubation time showed the highest nutrient content compared to other treatments.
2. Corn straw in Gorontalo regency after fermentation has better nutritional content and can be used in the formulation of super native chicken rations

Suggestion:-

Further research is needed to determine the effect of fermented corn straw on the quality and quantity of super native chicken production.

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