The 1st
International Vocational Agriculture Symposium
Volume 1 Nomor 1 April 2026

Quality Control of Tapioca Solid Waste (*Onggok*) as Feedstuff for Beef Cattle Concentrate in Feed Mill Using the Quick Test Method

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History Article:
- Submit: Juli 2025
- Publish: April 2026

Keyword:
Feed Mill, Feedstuff, Tapioca Solid Waste, Quality Control, Quick Test

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Abstract
Tapioca solid waste (onggok) is a by-product of tapioca starch production commonly utilized as ruminant feed in Indonesia. Dried powdered onggok is widely available and commonly used as a raw material in concentrate for ruminants. This study aimed to assess the quality control of onggok by conducting a quick test upon receiving these raw materials at the feed mill. The employed methodologies included survey administration, conducting interviews, and distributing questionnaires. We used descriptive analysis to describe the quality control used for the type of onggok. Regression analysis was applied to identify the relationship between density and moisture, as well as density and contaminants found in onggok. Onggok used in this study was sourced from Lampung. The quick test of onggok showed that the average moisture content of onggok was 27%, while the contaminants was 7.70%, and the average density was 289 g/L. Furthermore, this research was conducted with additional physical tests, including determining the dominant color (94% brownish white), evaluating the fragrance (56% odorless), and assessing the texture (100% mixed texture). The density of onggok had a weak correlation with its moisture and foreign matter content. The linear regression equation for the relationship between moisture content and density was Y = 182.513 + 3.940 X. The linear regression equation for the correlation between foreign matter contaminant content and density was Y = 298.864 + (-1.302) X, where Y was foreign matter, and X was density. The high fiber content of 21.7% in onggok categorized it as a raw material for fiber sources.

INTRODUCTION

In Indonesia, the utilization of agro-industrial waste as livestock feed is a widespread practice. Tapioca (*Manihot esculenta* Crantz) solid waste (locally called *onggok*) is the residue left after extracting starch from tapioca for commercial use. This product is easily accessible across the entire country, offered at an affordable price, and does not interfere with essential human needs. Beef and dairy cattle rations frequently include it as a feed ingredient.

Onggok is an agroindustrial waste product from tapioca flour production that can be used as a raw material for animal feed (Febrianti *et al.,* 2017). Onggok is a solid waste product from the cassava industry that still contains a high percentage of carbohydrates (63-68%). Using onggok as a feed material is quite promising because it contains 40.8 - 46.5% starch. The composition of cassava varies depending on the type of cassava, the region of origin, and the method used in the production of tapioca flour (Musita, 2018).

Tapioca waste is regarded as a high-energy diet for ruminant animals. According to Hambakodu and Ina (2019), the nutrient content of *onggok* is as follows 88.45% dry matter (DM), 5.81% crude protein (CP), 0.51% extract ether (EE), 8.13% crude fiber (CF), 4.13% ash, and 81.66% nitrogen-free extract.

The raw materials used as inputs in the Animal feed industry are obtained from various sources and they vary greatly in quality (Bidura, 2017). The quality level of raw feed materials that will be formulated into rations can be one of the benchmarks for measuring the quality of the resulting rations. The raw material samples, an inspection should be performed. Check for moisture content, color, odor, and the presence of foreign objects, texture, uniformity, and other defects. (Partama, 2017).

Utilizing *onggok* as an ingredient in feed compounding offers the advantage of reducing the expenses associated with the end product. Typically, the quantity of *onggok* utilized in concentrate rations ranges from 20 to 40%. Due to the significant quantity of *onggok* in the formulations, ensuring the acceptance of this raw material at the feed mill is of utmost importance. Therefore, it is imperative to carry out quality control tests before acceptance. This study aimed to assess the acceptance rate of raw *onggok* at selected feed mills using a qualitative quick test method. This method serves as a quality control measure during the delivery process.

RESEARCH METHODOLOGY

This study utilized records of tapioca solid waste (*onggok*), which was used as a feed ingredient at the feed mill of PT Widodo Makmur Perkasa Tbk (2) and the feedlots owned by the same company. The feed mills were in Cianjur and Cariu, West Java. The records under examination spanned from January to June 2022. The quality control processes were assessed by the administration of pre-prepared questionnaires and interviews with the management of the feed mills and feedlot farms. The database contains information on the quality of *onggok* (from publications of the Ministry of Agriculture). Additionally, data on the quick test method, including measurements of moisture content, foreign matter contaminant content, dry matter, density, texture, color, and odor, were also collected from feed mills and feedlots. A total of 184 *onggok* samples were collected from the database of laboratory studies obtained at the feed mill and sourced from raw material suppliers.

Interviews were also carried out with a total of 15 individuals, encompassing various roles such as production manager, quality control supervisor, production supervisor, quality control staff, feed mill administrator, and purchasing staff. The interview focused on the flow process of *onggok* upon arrival at the factory, the procedure for evaluating quality using the quick test method, and other quality-related concerns. Methods for quickly checking quality involved visual inspection for color, olfactory examination for odor, moisture determination through oven drying, contamination assessment by immersing *onggok* samples in a water-filled container, and density measurement by quantifying weight and volume in liters. The methodology employed in this study was the acquisition of data through surveys and interviews, which were subsequently organized and analyzed.

Data collection. The data acquired in this study consisted of both primary and secondary data. The primary data collected through surveys, questionnaires, and interviews, particularly at PT Widodo Makmur Perkasa Tbk, is subsequently analyzed and processed. Secondary data refers to additional information that supports the research. The researcher collected secondary data from reliable resources such as the Livestock Service Office, the Central Statistics Agency (BPS), and other relevant publications. Additional information related to the research was obtained from literature, libraries, and the internet. These data were compiled and analyzed to generate comprehensive and interpretable information

Data analysis. Descriptive analysis was conducted on the compiled database containing quick test results for 184 samples of raw *onggok*. The data was tabulated, and conclusions were drawn based on the analysis. Regression analysis was employed to ascertain the correlation between moisture content, foreign matter, and density.

RESULTS AND DISCUSSION

Origin of *onggok*

Onggok itself was a by-product of the tapioca flour manufacturing industry which comes from cassava (Riani *et al.,* 2023). *Onggok* was cassava waste that had enormous potential (Widodo *et al.,* 2011). According to the records, all *onggok* used by PT Widodo Makmur Perkasa Tbk feed mills originated from the Lampung region. Upon arrival, the incoming *onggok* underwent rigorous physical quality control testing. Subsequently, they were stored in the warehouse before being utilized in the preparation of animal feed. Figure 1 displays an image of *onggok* used by PT Widodo Makmur Perkasa Tbk.

Figure 1. Tapioca solid waste (*onggok*) from Lampung Used by PT Widodo Makmur Perkasa Tbk

Onggok quality test parameters

The mean moisture content (%), foreign matter (%) and density (g/L) are shown in Table 1.

Table 1. Quantitative Quick Test (Based on Moisture Content, Foreign Matter, and Density) of Raw Onggok Samples at the Feed Mills

Number of samples (n)	Max	Min	Average	Std	Mode	Median
184	33.1	13.6	27.0	4.30	26.3	27.1
184	20.7	1.30	7.70	3.40	8.00	7.70
184	467	157	289	55.9	284	284

Table 1 shows that the 184 *onggok* samples that were received had an average moisture content 27.0%. However, based on the publication by Hambakodu & Ina (2019) the moisture content of *onggok* was reported to be 11.55%. *Onggok* lacks a standardized mill requirement, hence its suitability as a feed ingredient is contingent upon the unique criteria set by each feed mill. Small-scale companies produce *onggok* meals with an average moisture level of 8.84%, whereas large manufacturers produce *onggok* with a moisture content of 4.25% (Abdullah *et al.*, 2019). The moisture content of *onggok* flour produced by large-scale manufacturers is lower compared to that of *onggok* flour from small-scale industries. The reason for this is the fact that *onggok* obtained from large factories had a lower concentration of starch and a larger concentration of fiber. *Onggok* flour from small-scale industries had a higher starch content compared to *onggok* flour from large industries, with a relatively lower fiber content (Abdullah *et al.*, 2019). The research results suggested that the higher moisture content in *onggok* might be attributed to the maximum accepted *onggok* acceptance standard of 25%. It is worth noting that the use of *onggok* is quite prevalent, which reduces the likelihood of long-term storage. The rainy season and dry season had a significant impact on the moisture content of *onggok*. The data on *onggok* arrival indicated a high level of moisture content. Monitoring the quality of feed and feed ingredients requires close attention to moisture content. This parameter serves as a crucial marker for the safe storage, mixing, and feeding of animals (Uyeh *et al.*, 2021). *Onggok*, a type of wet tapioca solid waste, is not resistant to storage. Therefore, it is important to ensure that the moisture content of *onggok* is less than 13% to ensure its safety and durability during storage (Bidura, 2016).

Onggok samples had an average level of foreign matter contaminants of 7.70%. The weight of contaminants other than pure *onggok*, such as sand, soil, stones, and other materials, contributed to the foreign matter contaminant content. Contamination may occur when the raw *onggok* is spread out under the sun during the drying process. When drying *onggok*, it is common practice to spread it on concrete floors or plastic sheets on the ground. However, this method often leads to a high risk of soil contamination. Recognizing *onggok* adulteration can be based on contaminant levels. Raw materials undergo natural variations and processing, resulting in variations in the content of food substances. Raw *onggok* is often contaminated or deliberately mixed with foreign matter, which can reduce its quality. Therefore, it is imperative to do physical examination to ascertain the material's purity (Jaelani, 2021).

At the processing plant, *onggok* had an average density of 289 g/L. Bidura (2016) stated that the bulk density of *onggok* flour ranged between 552 to 533 g/L. Qualitatively, the quality of *onggok* can be tested using bulk density or buoyancy tests (Jaelani, 2021). Density is employed to determine the level of compactness and texture of the feed. A compact feed texture will withstand the pressing process, preventing the formation of air pockets between the bindings between the ingredients. The density of a substance determines its ability to fill and occupy space in silos, containers, and packaging.

Table 2 included color, odor, and texture in addition to the three parameters mentioned above for conducting a quick quality control test on *onggok*. The color was characterized as either ash white, brownish white, or brown. The odor was described as fragrant, less fragrant, or not fragrant (bad smell). The texture was described as either smooth to the touch (fine and uniform) or mixed (coarse and gritty to the touch).

Organoleptic tests such as taste, color, and smell can be used to determine the quality of good *onggok* (Jaelani, 2021). Table 2 indicated that 94% of the sampled *onggok* had a brownish white color, as determined by the physical criteria. According to Musita (2018) *onggok* flour from large processing plants was darker in color (slightly brown) than *onggok* flour from small industries. The difference was attributed to various factors, such as the variety of cassava and the technique employed to extract tapioca flour. Most of the cassava utilized by the tapioca sector is sourced from local cassava farmers in the region and transported to the processing factory. However, only a small amount is obtained from the company's plantations. The cassava exhibited diverse types, leading to inconsistent quality of the *onggok*. The difference in the amount of yield of each variety is caused by the genetics of each cassava plant

(Nugraha *et al.*, 2015). The whiteness level of flour directly impacts the quality of the *onggok* produced (Raysita and Pangesthi, 2013). The whiteness of cassava flour is affected by the raw materials used and the techniques employed during production. Large processing plants typically discard and do not utilize *onggok*, without any further processing. Once the extraction process finishes, they stack the *onggok* before proceeding with the drying process. The piling process results in a darker color of the *onggok* due to microbiological activity. Furthermore, impurities from the remnants of washing raw materials also contribute to the discoloration of *onggok*, preventing it from achieving a white color. According to Nyoman *et al*. (2014) the color parameter exhibited various variations in nearly every sample, ranging from a yellowish white to a blackish grey. The blackish-gray color of *onggok* is a result of transporting wet *onggok* without sifting it before drying. Additionally, the lack of active workers flipping the *onggok* leads to water deposits in the lower layers, resulting in a slight blackish color on the *onggok*. Furthermore, the color of the *onggok* is closely related to the age of the cassava at the time of harvest. The *onggok* color will be whiter and cleaner if the cassava is younger. Based on the average organoleptic test, it was observed that the *onggok* dried on the cement floor had a brownish-white color, whereas the *onggok* dried on the ground appeared brown.

Table 2. Qualitative quick test method based on physical characteristics (color, odor and texture) of raw *onggok* received at feed mills

Parameter	Number of samples (n)	Percentage (%)
Color:		
a. Ash white	7	3.80
b. Brownish white	173	94.0
c. Brown	4	2.20
Odor:		
a. Fragrant	14	7.60
b. Less fragrant	103	56.0
c. Not fragrant	67	36.4
Texture:		
a. Smooth	0	0
b. Mixed	184	100

Physical quality based on odor in Table 2 shows that the aroma is less fragrant (56%) with the highest percentage. The odor can be used to determine whether the item was fresh, moist fermented, or not. *Onggok* emits a noxious smell, particularly when it is dry, and even more so when it is wet, particularly during the rainy season (Musita, 2018). The results of this organoleptic test showed no difference in the aroma parameter of *onggok* dried on cement floors compared to those dried on the ground. The condition occurs because the *onggok* samples utilized are specifically designated for animal feed, resulting in the production of *onggok* with the identical aroma for each sample.

Considering texture, all the *onggok* samples indicated a mixed texture classification, implying that the *onggok* used were not subjected to any pre-processing or grinding before being delivered to the feed mill. In this instance, the *onggok* utilized was not a type of flour, resulting in a significant variation in texture and particle size, with a mixture of small and large lumps. There were differences in the textural characteristics between *onggok* dried on cement floors and those dried on the ground. There are three different textures: hard, slightly hard, and crumbly. The variation in water content of the samples was caused by factors such as weather conditions, temperature, and the thickness of the spread of *onggok* during drying. The texture of the *onggok* generated became harder as the water content increased in each sample. The excessive thickness of the *onggok* throughout the drying process, combined with infrequent rotation by workers, resulted in water accumulation in the lower layer of the *onggok*. It led to high water content and a hardened texture of the *onggok* (Nyoman *et al*., 2014).

Some of the raw *onggok* delivered to the animal feed factory were rejected due to failure to satisfy the standards set forth. Table 3 displays the parameters for rejection of raw *onggok*.

Table 3. Rejection of Raw Onggok Based on Moisture Content and Foreign Matter Contents for Beef Cattle Concentrate

Min	Average	Std	Mode	Median
12.7	33.8	9.20	36.0	36.4
1.20	10.2	7.60	1.00	7.00

According to Table 3, the rejected samples had an average moisture content of 33.8% and an average foreign material content (contaminant) of 10.2%. The percentage of rejection parameters can be seen in Figure 2. Figure 2 shows the primary factor for rejecting *onggok* raw materials is the moisture content, which accounts for 60% of the rejection parameter. Moisture content is a crucial determinant. Damage can result from mold attack caused by excessive moisture, rancidity, and insect infestation. Rigorous quality monitoring of raw materials is essential during the process of receiving and storing them. The selection and management of raw material quality is a crucial step in the production of high-quality rations (Jaelani, 2021). The foreign matter contamination level (40%) represents the proportion of foreign objects that are not *onggok*. Raw materials frequently encounter contamination or intentional admixture with foreign substances, which can diminish their quality. Therefore, it is imperative to conduct physical testing to determine the purity of the material (Jaelani, 2021). During January, Indonesia hits the peak of its rainy season, which slows the drying process for *onggok*. *Onggok* drying mostly relies on sunlight, therefore the wet season poses challenges due to increased water content. The peak of the 2021/2022 rainy season in the majority of the Seasonal Zone (ZOM) regions is forecasted to transpire between January and February 2022 (Badan Meteorologi Klimatologi dan Geofisika, 2021).

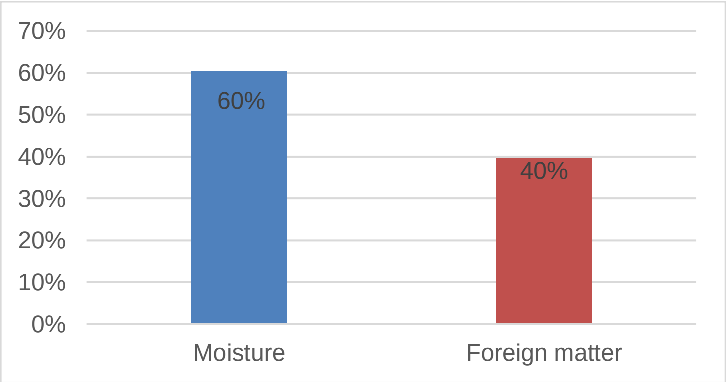

Figure 2. Percentage (%) of Raw *Onggok* Rejection at Feed Mills Based on Moisture (Blue) and Contaminant (Red)

Relationship between water and foreign matter content and density of *onggok*

The relationship between density, foreign matter contaminant content, and water content is illustrated in Table 4. The relationship for estimating curvature is depicted in Figures 3 and 4.

Table 4. Regression of Density with Moisture Content and Foreign Matter Contaminant Content

Parameter 1	Parameter 2	Sig	Regression Model	R	R^2
Moisture content	Density	0.00	Y = 182.513+ 3.940 X	0.30	0.09
Foreign matter contaminants	Density	0.28	Y = 298.864 + (-1.302) X	0.08	0.01

The correlation between density and water content is positive, whereas the correlation between density and foreign matter contaminants is negative, as shown in Table 4. The regression equation that relates moisture content (Y) to density (X) is given by Y = 182.513 + 3.940X. The regression equation that relates the foreign matter contamination content to the density is given by Y = 298.864 + (-1.302) X. With a correlation coefficient of 0.30 or 30% and a coefficient of determination of 0.09 or 0.90%, the regression results between water content and density indicate that the water content variable influences the density variable by 0.90%, while other factors account for the remaining 99.1%. The significance ($P<0.05$) is satisfied by the regression equation model based on the research data, as indicated by the Sig value of 0.00 ($P<0.001$). Consequently, the linear regression model meets the linearity criteria.

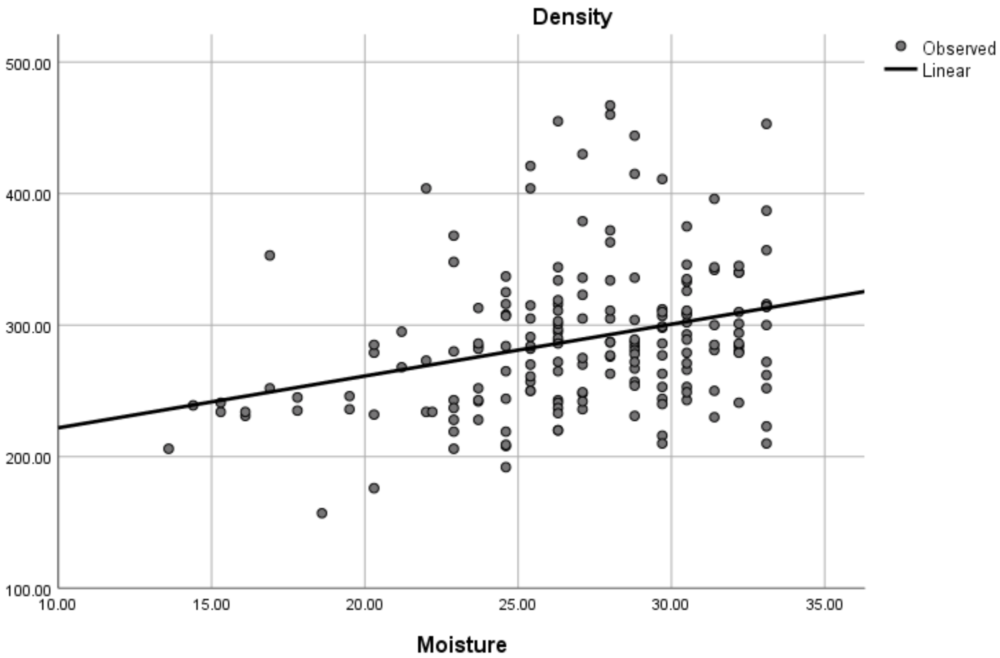

Figure 3. Curva estimation regression of *onggok* moisture and density

The regression analysis reveals a correlation coefficient of 0.08 or 8.00% between levels of foreign matter contaminants and density, accompanied by a coefficient of determination of 0.01 or 0.10%. It indicates that the levels of foreign matter contaminants exert a mere 0.10% influence on the density variable, with the remaining 99.9% being accounted for by other factors. The obtained Sig value of 0.28 does not meet the significance threshold ($P>0.05$). Consequently, the regression equation model constructed using the research data was deemed insignificant, and the linear regression model failed to satisfy the linearity criteria. The coefficient of determination interval ranging from 0.00 to 0.199 exhibited a negligible degree of correlation (Sugiyono, 2019). Consequently, the relationship between density and the concentrations of foreign matter contaminants and water is also exceedingly weak.

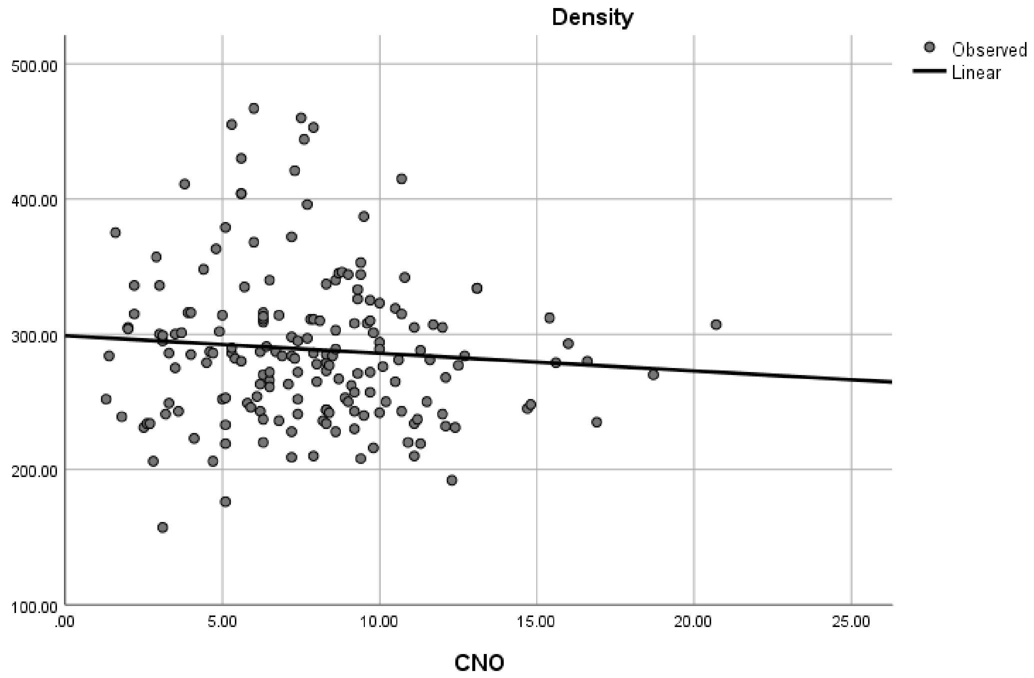

Figure 4. Curva estimation regression of foreign matter contaminant and density

Chemical quality parameters of *onggok*

The nutrient composition of six samples of *onggok* analyzed at the laboratory is shown in Table 5.

Table 5. Proximate analysis data of *onggok* as raw material for cattle concentrate

Name	Proximate Analysis (%)						
	DM	Ash	CP	EE	CF	NFE	TDN
Onggok 1	88.8	1.83	0.99	2.13	21.8	73.2	74.2
Onggok 2	84.2	4.16	4.59	1.80	24.6	64.8	64.0
Onggok 3	72.7	4.13	2.56	0.84	20.4	72.1	70.4
Onggok 4	87.7	6.34	2.18	0.33	27.7	63.4	62.4
Onggok 5	89.5	9.26	2.98	0.54	19.6	67.6	52.3
Onggok 6	88.2	2.58	2.15	1.59	15.8	77.9	74.17
Average	85.2	4.72	2.58	1.21	21.7	69.9	66.2

DM = Dry Matter, CP = Crude Protein, CF = Crude fiber, EE = Ether Extract, Ash, NFE: Nitrogen Free Extract, TDN = Total Digestible Nutrient

The laboratory analysis suggested that the *onggok* samples contained crude fiber (CF) at 21.7% and crude protein (CP) at 2.58% on average. According to Syafrudin *et al*. (2020), *onggok* has a crude protein content of 5.9% and a crude fat content of 2.6%. *Onggok* was a tapioca waste product with low levels of protein and crude fat but high levels of carbohydrates (Bakrie *et al*., 2018). According to Wachdijono and Julhan (2019), tapioca waste from agro-industry generally has a protein content of 5% and quite high crude fiber, however, it has not been utilized optimally. Bagau and Embar (2017) report that energy source raw materials consist of substances containing no more than 20% crude protein, 18% crude fiber, or 35% cell walls. Given that *onggok* contains over 18% crude fiber, it qualifies as a fiber source group. Abdullah *et al*. (2019), the crude fiber content of *onggok* from large industries was 21.3%, but small-scale *onggok* had a much lower concentration of only 6.77%. The difference in starch content and crude fiber content occurs from the utilization of machines support in large-scale enterprises for starch extraction, resulting in a higher yield. Conversely, small-scale industries rely on manual extraction methods, which are less precise and yield lower amounts of starch.

CONCLUSIONS AND SUGGESTION

The tapioca solid waste (*onggok*) collected from the feed mills and feedlots originated from Lampung region. The quick test performed for quality control of *onggok* yielded the following results: the average water content was 27%, the average concentration of foreign matter contaminants was 7.70%, and the average density was 289 g/L. Furthermore, other inspections were conducted, specifically focusing on the dominant color of brownish white (94%), odorless fragrant (56%), and a mixed texture (100%). The feed mill rejected the *onggok* quality primarily because of its highwater content (60%) and its levels of foreign matter contaminants (40%). The correlation between moisture and foreign matter contamination content and density is weak. The regression equation that relates moisture content (Y) to density (X) is given by Y = 182.513 + 3.940X. The regression equation that relates the foreign matter contamination content to the density is given by Y = 298.864 + (-1.302) X. Quick test of raw materials can be attempted not only for *onggok* but also for other agricultural by-products to determine whether their physical quality meets specifications.

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