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Research Article

Identification of Pollard and Fishmeal Adulteration in Central Java Province Indonesia

Cahya Setya Utama[1]*, Bambang Sulistiyanto[1], Nadya Marcelina Cinderawati[2]

Laboratory of Feed Technology, Department of Animal Science, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia; [2]Postgraduate Program, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia.

Abstract | Feed ingredient adulteration threatens feed safety and nutritional quality, particularly in high-value ingredients such as pollard and fishmeal. The research aims to examine the practice of counterfeiting in pollard as a source of energy and fishmeal as a source of protein feed ingredients in Central Java are often faked. This study was limited to Central Java; wider studies are needed for more comprehensive findings. The materials used are, pollard and fishmeal as much as 1 kg each from 17 regions (regencies/cities) in Central Java which include the areas of Rembang, Jepara, Batang, Solo, Boyolali, Pekalongan, Kendal, Temanggung, Magelang, Ungaran, Pati, Purwodadi, Demak, Salatiga, Kudus, Klaten and Semarang. The research method uses a quantitative descriptive method. The quantitative aspect was presented using measurable test results and simple descriptive statistics. Samples were taken purposively random samples to represent the area used as a research site (10 stores in 1 city/district area). The measurement of pollard adulteration parameters was carried out by phloroglucinol testing, float test and bulk density test, while fishmeal used urea test. The results showed that most of the pollard and fishmeal in Central Java were still of good quality, but pollards from Jepara, Solo, Temanggung, Pati, Purwodadi, and Salatiga were indicated to be counterfeited based on phloroglucinol tests and float tests. Samples from Ungaran and Pati had a substandard bulk density. Fishmeal samples in Boyolali are indicated to be adulterated with urea and have a fishy odor that is more pungent than other areas. There is a pollard sample from Pati that was found to be contaminated by fleas. Counterfeiting and contamination detected in several samples may negatively affect the physical characteristics and nutritional value of feed ingredients.

Keywords | Central Java, Fishmeal, Pollard, Adulteration

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***Correspondence** | Cahya Setya Utama, Laboratory of Feed Technology, Department of Animal Science, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia; **Email:** cahyasetyautama@gmail.com
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INTRODUCTION

Feed is a fundamental component of livestock production systems because it directly influences animal health, growth performance, feed efficiency, and the quality of animal-derived products. Therefore, the quality of feed ingredients, particularly energy and protein sources, is critical in ration formulation. Pollard and fishmeal were emphasized in this study because they are widely used as major energy and protein sources and are economically vulnerable to adulteration practices. The quality of feed is greatly influenced by the quality of the feed material. Based on this, farmers and feed producers need quality assurance that can minimize the possibility of counterfeiting feed ingredients. The international guideline Code of Practice on Good Animal Feeding (CAC/RCP 54-2004), which was updated until 2020, explains that feed ingredients used in rations are prohibited from being counterfeited and must not be contaminated. These guidelines emphasize that feed ingredients must be safe, free from harmful contaminants, properly handled, and not adulterated in ways that may negatively affect animal health or food safety in livestock production systems. Falsification with the addition of non-nutritional ingredients or the replacement of high-quality raw materials can reduce livestock performance, cause economic losses, and even endanger the health of consumers of animal products (Hernaman et al., 2024). Examples of non-nutritional adulterants commonly reported in feed materials include rice husks, sand, limestone powder, sawdust, and non-protein nitrogen compounds such as urea. The presence of biological, chemical, and physical contaminants in feed ingredients represents a significant risk to food safety. However, the practice of counterfeiting or substituting feed ingredients with cheap and non-nutritious components is still often encountered. Reports of inconsistent physical quality and suspected adulteration are still encountered in several feed markets in Central Java. Such adulteration practices may occur at different stages of the supply chain, including distribution, storage, and retail marketing. A number of feed ingredients that are often counterfeited, namely pollard and fishmeal. Poor-quality or adulterated feed ingredients may reduce nutrient utilization, decrease animal productivity, impair health status, and increase economic losses in livestock production systems. In addition, contaminated feed ingredients may affect food safety and the quality of animal-derived products consumed by humans. These feed ingredients are particularly vulnerable to adulteration because they are widely used in ration formulations, traded in large volumes, and have relatively high economic value compared to many other feed materials.

Pollard is a by-product of wheat milling that still contains some endosperm, so it has a better nutrient content than coarse bran. Pollard is widely used for both poultry and ruminant rations because it contains relatively high digestible carbohydrates and has a finer particle texture than coarse bran (Umami *et al*., 2023). Good-quality pollard generally has a light brown color, fine and uniform texture, characteristic wheat odor, and minimal visible husk particles. However, pollard has a fairly high level of crude fiber and variability in quality (Trisnadewi *et al*., 2020). Pollard is traded in large quantities at competitive prices, thus opening up opportunities for individuals to carry out counterfeiting and bribery practices. Pollard is usually substituted with inexpensive materials such as rice husks, lime, sand, or sawdust. Another feed ingredient that has the potential to be counterfeited is fishmeal.

Fishmeal is a high-quality animal protein source feed with a protein content of 50–72%, complete essential amino acids, rich in omega-3 fatty acids, calcium, and phosphorus. Fishmeal is commonly used in poultry and aquaculture rations to improve protein quality, amino acid balance, and feed palatability. Its advantages lie in its high digestibility and its beneficial effects on animal growth and immune function (Daniel, 2018). Good-quality fishmeal generally has a characteristic fish odor, brownish color, dry texture, and does not contain excessive non-protein nitrogen compounds. However, the price of fishmeal is relatively expensive, its availability is seasonally limited, and it is easily damaged by fat oxidation (Jannathulla *et al*., 2019). Fishmeal is frequently adulterated with low-cost materials such as feather meal, bone meal, bran, or even sand due to its high economic value. The practice of counterfeiting fishmeal also often uses urea which risks harming farmers and the feed industry. Although the prevalence may vary among regions, the use of non-protein nitrogen compounds such as urea has been reported as a potential adulteration practice in commercial feed materials.

The effort needed to prevent losses to farmers and feed producers due to counterfeiting practices is to test the authenticity of feed ingredients. Suspected counterfeiting of pollard feed materials can be detected using several simple methods. Phloroglucinol testing has been widely applied for detecting lignin-containing adulterants such as rice husks in feed materials (Albarki *et al*., 2023; Hernaman *et al*., 2024). Float tests are commonly used to identify low-density adulterants such as husks or sawdust based on their floating properties in water (Nafisah and Nahrowi, 2021). Bulk density tests are used to compare pollard density with normal reference values, where abnormal values may indicate adulteration with lighter or heavier materials (Nuraina *et al*., 2020). Meanwhile, the authenticity of fishmeal can be tested with a urea test. Urea testing is commonly used as a rapid method to detect non-protein nitrogen adulteration in fishmeal (Islam *et al*., 2016; Chanawanno *et al*., 2023). Although other non-protein nitrogen compounds may also be used as adulterants, urea is one of the most commonly reported substances because it can artificially increase measured nitrogen levels in protein analysis. The application of simple and advanced test methods is an important step in the feed quality control system to ensure safety, prevent economic losses, and protect the health of livestock and end consumers.

The research aims to comprehensively examine the practice of counterfeiting in pollard feed and fishmeal ingredients in Central Java. This action is also an effort to test the effectiveness of simple methods such as phloroglucinol test, float test, bulk density test, and urea test in detecting substitution or addition of non-nutritional ingredients. This research is expected to support farmers, feed producers, and other stakeholders in improving feed quality control, reducing economic losses, maintaining livestock productivity, and ensuring feed safety.

MATERIALS AND METHODS

The materials used in this study were pollard and fishmeal taken from 17 districts/cities in Central Java.

This study uses a quantitative descriptive method with the data obtained processed in a measurable manner and presented in the form of a structured table. The research process began with sampling in the form of pollard and fishmeal as much as 1 kg each from 17 regions (regencies/cities) in Central Java using the purposive random sampling technique. Each 1 kg sample represented a composite sample obtained from several sub-samples collected from different portions of the feed material available in each store. The selection of the region was carried out by considering the availability and continuity of the feed materials studied. Data were taken from 10 different shops in the sub-district or village of the designated area with consideration of the intensity of sales of the feed ingredients. The selected stores were located in active feed trading areas within each district/city and were considered representative of local commercial feed distribution. Feed stores included in the study were active poultry or livestock feed retailers that routinely sold pollard and fishmeal products. Samples were stored in sealed plastic containers at room temperature and analyzed immediately after collection to minimize quality changes during storage. The districts/cities that were used as research locations include Rembang, Jepara, Batang, Solo, Boyolali, Pekalongan, Kendal, Temanggung, Magelang, Ungaran, Pati, Purwodadi, Demak, Salatiga, Kudus, Klaten, and Semarang. The selected districts/cities represent major livestock and feed trading centers in Central Java, thereby providing a representative overview of feed adulteration practices despite not covering all administrative regions. The sample taken has been confirmed by organoleptic observation, so it was identified as pollard without a response. Organoleptic observations, including color, texture, and odor, were qualitatively conducted by the research team during sampling and laboratory evaluation as supportive observations rather than formal sensory analysis. The evaluated parameters included moisture content, bulk density, biological contamination, lignin indication through phloroglucinol reaction, floatability, and non-protein nitrogen (urea) adulteration. Most pollard samples traded in Central Java were locally distributed commercial products commonly available in feed stores. Meanwhile, the fishmeal samples used in this study were locally produced (non-imported) products commercially distributed in feed stores in Central Java.

Research procedure

Pollard adulteration testing includes phloroglucinol test, float test and bulk density test and fishmeal testing using urea test.

Phloroglucinol test

Pollard samples were sieved to obtain uniform particle size before analysis. Approximately 1 g of sample was placed in a petri dish and treated with five drops of 1% phloroglucinol solution prepared in ethanol. Observations were conducted visually after 1–2 minutes at room temperature. The appearance of red spots indicated lignin-containing materials such as rice husks, while foam formation suggested possible inorganic adulterants (Hernaman *et al.*, 2024). Each sample was analyzed in triplicate.

Husk float test

A total of 5 g pollard sample was placed into a 250 mL beaker containing 150 mL clean water at room temperature (27–29°C). The sample was left undisturbed for 15 minutes without stirring. Floating particles observed on the water surface indicated the possible presence of husks or other light adulterants (Rusyidi *et al.*, 2023). Each test was conducted in triplicate.

Bulk density test

Bulk density was measured using a 500 mL measuring cup and a digital balance with 0.01 g accuracy. Pollard samples were homogenized before testing. The measuring cup was filled carefully without compression or shaking to avoid artificial densification. Measurements were conducted in triplicate and expressed as mean ± standard deviation. The normal density of pollard ranges from 390-570 kg/m3 or equivalent to 0.39-0.57 g/mL. The calculation of pollard bulk density uses an equation with a formula that refers to the research of Nuraina *et al.* (2020):

$$Bulk\ density = \frac{sample\ mass\ (g)}{Volume\ (mL)}$$

Urea test

Approximately 1 g of finely ground fishmeal sample was placed onto urea test paper and moistened with 2–3 drops of distilled water. Color changes were observed within 1–2 minutes. A blue color indicated the presence of urea-based non-protein nitrogen adulteration. Positive and negative controls were prepared using pure urea and non-adulterated fishmeal, respectively. All tests were conducted in triplicate. This method is simple, fast, and effective for detecting the addition of non-protein nitrogen to fishmeal (Chanawanno *et al.*, 2023).

Data analysis

Quantitative data such as bulk density and moisture content were expressed as mean ± standard deviation from triplicate measurements. Qualitative test results including phloroglucinol, float, contamination, and urea tests were categorized descriptively as positive or negative based on visual observations (Utama and Sulistiyanto, 2021). The results were presented in tabular form and interpreted by comparing them with relevant feed quality standards from previous studies.

RESULT

Phloroglucinol test on pollard

The results of the study (Table 1) show that of the 17 districts tested, six districts showed positive results Jepara, Solo, Temanggung, Pati, Purwodadi, and Salatiga whereas the remaining 11 districts showed negative results. A positive result in the phloroglucinol test indicates the presence of lignin from husk, suggesting that pollard from the region was adulterated by the addition of husks. Husk content exceeding the tolerance limit of 5% has implications for a decrease in the quality of pollard as a feed material. The 5% threshold was used as a practical reference based on previous feed quality evaluation studies rather than an official Codex standard.

Husk float test on pollard

Based on the float test (Table 1), results were consistent with the phloroglucinol test. There are six districts with positive results, namely Jepara, Solo, Temanggung, Pati, Purwodadi, and Salatiga, whereas the remaining districts showed negative results. A positive float test indicates the presence of husk particles floating on the surface. The more particles that float, the lower the quality of pollard, because husks cannot be digested efficiently by livestock and are bulky, thereby reducing digestive efficiency.

Bulk density test on pollard

The results of bulk density measurement showed variation in values among districts (Table 1). Some areas have substandard values, namely Ungaran (0.35 ± 0.02 g/mL) and Pati (0.36 ± 0.01 g/mL). Indicating possible adulteration with the addition of rice husks. Meanwhile, there were no districts with values above normal indicating that there was suggesting the absence of adulteration with inorganic materials such as lime flour or stone flour. Other districts showed bulk density values within the normal range of 0.39–0.57 g/mL based on the reference reported by Nuraina *et al.* (2020). Rice husks have low bulk density because of their hollow lignocellulosic structure and high fiber content, which reduce overall material compactness. However, bulk density may also be influenced by particle size, moisture content, compaction level, and measurement procedures; therefore, low bulk density alone cannot conclusively indicate adulteration. For this reason, bulk density results were interpreted together with phloroglucinol and float test findings.

Urea test on fishmeal

The results of the urea test on fishmeal (Table 1) showed that only Boyolali Regency tested positive, while the remaining 16 districts were negative. This positive result

Table 1: Data from the pollard and fish meal adulteration test.

No.	Regency	Pollard			Fishmeal
		Phloroglucinol Test	**Float Test**	**Bulk Density (g/ml)**	**Urea Test**
1	Rembang	Negative	Negative	0.45 ± 0.01	Negative
2	Jepara	Positive	Positive	0.46 ± 0.01	Negative
3	Batang	Negative	Negative	0.45 ± 0.02	Negative
4	Solo	Positive	Positive	0.46 ± 0.04	Negative
5	Boyolali	Negative	Negative	0.48 ± 0.01	Positive
6	Pekalongan	Negative	Negative	0.46 ± 0.03	Negative
7	Kendal	Negative	Negative	0.49 ± 0.01	Negative
8	Temanggung	Positive	Positive	0.51 ± 0.02	Negative
9	Magelang	Negative	Negative	0.46 ± 0.01	Negative
10	Ungaran	Negative	Negative	0.35* ± 0.02	Negative
11	Pati	Positive	Positive	0.36* ±0.01	Negative
12	Purwodadi	Positive	Positive	0.39 ± 0.01	Negative
13	Demak	Negative	Negative	0.4 ± 0.01	Negative
14	Salatiga	Positive	Positive	0.57 ± 0.02	Negative
15	Kudus	Negative	Negative	0.56 ± 0.04	Negative
16	Klaten	Negative	Negative	0.56 ± 0 01	Negative
17	Semarang	Negative	Negative	0.5 ± 0.01	Negative

Information: Samples from each district were taken from 10 different feed store locations. *Not meeting the normal density of pollard, the normal density of pollard is 0.39 – 0.57 g/ml (Nuraina *et al.*, 2020).

Table 2: Pollard organoleptic test results.

No.	Regency	Color	Smell	Texture	Moisture content (%)	Contamination
1	Rembang	Beige	Sweet	Soft	12.19	Negative
2	Jepara	Dark chocolate	Wheat Specialty	Fine Details	11.24	Negative
3	Batang	Beige	Slightly Sweet	Soft	12.97	Negative
4	Solo	Dark chocolate	Fresh Wheat	Fine Details	10.62	Negative
5	Boyolali	Light Chocolate	Wheat Specialty	Slightly rough	11.9	Negative
6	Pekalongan	Light Chocolate	Wheat Specialty	Slightly rough	11.6	Negative
7	Kendal	Light Chocolate	Wheat Specialty	Fine Details	11.6	Negative
8	Temanggung	Light Chocolate	Wheat Specialty	Slightly rough	12.4	Negative
9	Magelang	Chocolate	Wheat Specialty	Slightly rough	12.3	Negative
10	Ungaran	Beige	Wheat Specialty	Slightly rough	12.7	Negative
11	Pati	Tanned	Wheat Specialty	Soft	11.2	Louse
12	Purwodadi	Light beige	Wheat Specialty	Rough	12.7	Negative
13	Demak	Light Chocolate	Wheat Specialty	Rough	9.7	Negative
14	Salatiga	Light Chocolate	Wheat Specialty	Soft	8.5	Negative
15	Kudus	Light Chocolate	Wheat Specialty	Soft	8.2	Negative
16	Klaten	Light Chocolate	Wheat Specialty	Soft	12.3	Negative
17	Semarang	Light Chocolate	Wheat Specialty	Soft	12	Negative

Table 3: Fishmeal organoleptic test results.

No	Regency	Color	Smell	Texture	Moisture content (%)	Contamination
1	Rembang	Light Chocolate	Fishy	Soft	11.06	Negative
2	Jepara	Dark Chocolate	Fishy specialties	Fine Powder	19.6	Negative
3	Batang	Light Chocolate	Slightly fishy	Soft	11.11	Negative
4	Solo	Dark Chocolate	Fishy	Rough	17.56	Negative
5	Boyolali	Dark Chocolate	Fishy Stings	Fine Powder	8.1	Negative
6	Pekalongan	Dark Chocolate	Fishy	Soft	8.2	Negative
7	Kendal	Dark Chocolate	Fishy	Soft	12.6	Negative
8	Temanggung	Dark Chocolate	Fishy	Soft	11	Negative
9	Magelang	Dark Chocolate	Fishy	Soft	10	Negative
10	Ungaran	Beige	Fishy	Fine Powder	7.9	Negative
11	Pati	Chocolate	Fishy	Soft	8.6	Negative
12	Purwodadi	Dark Chocolate	Fishy	Soft	20	Negative
13	Demak	Chocolate	Fishy	A Bit Rough	8.6	Negative
14	Salatiga	Dark Chocolate	Fishy	Soft	8.9	Negative
15	Kudus	Chocolate	Fishy	Soft	8.2	Negative
16	Klaten	Chocolate	Fishy	Soft	8.3	Negative
17	Semarang	Chocolate	Fishy	Soft	8.4	Negative

shows the presence of presence of urea in fishmeal. The addition of urea aims to increase the total nitrogen level so that the measured protein content becomes higher in the proximate analysis. However, biologically, urea is not a true protein, but a non-protein nitrogen (NPN) that cannot be efficiently utilized by monogastric livestock, and even may pose toxic effects if used excessively.

DISCUSSION

Phloroglucinol test

The results of the phloroglucinol test on pollard showed that most samples from different districts gave negative results, which means there was no indication of rice husk mixing. However, there were 6 samples, namely from Jepara, Solo, Temanggung, Pati, Purwodadi, and Salatiga

Regencies, which showed positive results. A positive result on the phloroglucinol test indicates the presence of lignin from the husk, as the lignin will react with the phloroglucinol reagent and produce a red color (Albarki *et al*., 2023). The reaction occurs through condensation between phloroglucinol and aromatic aldehyde groups in lignin under acidic conditions, forming chromophoric compounds that produce a characteristic red coloration. Therefore, the appearance of red color indicates the presence of lignin-rich materials such as rice husks in pollard samples. Phloroglucinol can be used to determine the good quality of pollard based on its crude fiber content, starting from 5%, 10%, 15%, 20% and 25% (Hernaman *et al*., 2024). Crude fiber components in pollard include lignin, cellulose, hemicellulose, and related structural carbohydrates; however, the phloroglucinol reaction specifically indicates the presence of lignin-associated materials. When compared to organoleptic results, pollards from the region have physical characteristics that are not the same as others. The texture of pollard from these regions tends to be rougher with a light to dark brown color, while samples from other regions generally have a smoother texture with a beige or light brown color. Authentic pollard generally has a fine, uniform texture with minimal coarse particles, whereas adulterated pollard mixed with rice husks tends to show a rougher texture, darker color, and visible fibrous particles that deviate from normal feed quality characteristics. These differences in texture and color reinforce the results of the phloroglucinol test that the feed material may have been falsified with the addition of ground rice husks. In addition, mixing husks can reduce quality because the nutritional content of husks is lower than pure pollard (Rusyidi *et al*., 2023).

Husk float test

The float test is used to detect counterfeiting with husks because husks have a lighter specific gravity so that they float easily in water (Utama and Sulistiyanto, 2021). Based on the results of the study, almost all pollard samples from various districts showed good quality with negative results in the float test. However, just like in the phloroglucinol test, samples from Jepara, Solo, Temanggung, Pati, Purwodadi, and Salatiga districts showed positive results. The more particles that float, the worse the quality of the pollard. The float test in this study was used as a qualitative screening method to indicate the possible presence of low-density adulterants such as rice husks or sawdust. Therefore, the interpretation was strengthened by combining float test observations with phloroglucinol and bulk density results. The combination of phloroglucinol reaction, float test observations, and bulk density measurements provided complementary information for identifying possible pollard adulteration. Rice husks contain high lignocellulosic components and hollow fiber structures that contribute to lower density and floating characteristics in water. The particles that float in the float test are husks, the bulk density of the husk is smaller when compared to the bulk density of pollard so that the husk will float (Illankoon *et al*., 2023). According to Roba *et al*. (2022) low husk nutrition causes indigestion when feed is given to livestock. The link with organoleptic results is also clearly visible. Pollards from the region tend to have a rougher texture than other regions, and the color tends to be dark brown. This physical nature is consistent with the alleged mixing of husks, as husks have coarse fibers that are easily detectable on physical observation (Chen *et al*., 2017). Thus, the combination of float and organoleptic test results provides strong evidence of a decline in pollard quality in both regions.

Bulk density test

Bulk density or specific gravity is one of the important indicators to assess the quality of feed materials. Pollards with a standard bulk density indicate that the material is still pure, while values that are too low or too high can indicate mixing with other materials. A good bulk density for pollard ranges from 338.39 g/l to 386.47 g/l (Nafisah and Nahrowi, 2021). According to Nuraina *et al*. (2020), Bulk Density Pollard is usually in the range of 0.39-0.57 g/mL. The results of the study showed that several areas had a substandard bulk density value, namely Ungaran and Pati. This low value leads to the possibility of mixing with lighter husks (Maesaroh *et al*., 2023). On the other hand, no bulk density values were found that exceeded the standard in the tested samples. This indicates that there is no sub-layer in the form of adding denser materials, such as stone flour or lime, which is used to increase feed weight unnaturally (Wei *et al*., 2024). Samples with low bulk density have a coarser texture with an indication of husk mixing. This variation shows that the quality of pollard in Central Java is not completely uniform and there are still indications of counterfeiting. Excessive fiber and lignin content may reduce nutrient digestibility and feed efficiency, particularly in poultry, whereas ruminants may tolerate fibrous materials better due to microbial fermentation in the rumen. However, excessive adulteration may still negatively affect animal performance indicators such as average daily gain (ADG) and feed conversion ratio (FCR).

Test urea on fishmeal

The urea test on fishmeal was carried out to determine the presence of counterfeiting with the addition of urea (Utama and Sulistiyanto, 2021). Based on the test results, almost all fishmeal samples from various districts showed negative results, indicating that no detectable urea-based non-protein nitrogen (NPN) adulteration was found. However, negative urea test results do not necessarily indicate that the overall quality of fishmeal is good, because other forms of adulteration, deterioration, or contamination may still occur. However, fishmeal from Boyolali showed positive results indicating the addition of urea. Counterfeiting using urea is seen from the change in color on the urea test paper which becomes blue. The blue color change occurs because the urease enzyme hydrolyzes urea into ammonia (NH_3) and carbon dioxide (CO_2). The released ammonia increases alkalinity, causing the indicator on the test paper to turn blue (Utama and Sulistiyanto, 2021). This is in accordance with the opinion (Yazarel *et al*., 2025) that urease is an enzyme that can break down nitrogen and carbon bonds in amide compounds and then form ammonia so that it causes the environment to become alkaline and alkaline pH and then change color to blue. The presence of urea in fishmeal may result from intentional adulteration practices aimed at artificially increasing crude protein values measured by nitrogen-based proximate analysis. Although ruminants are able to utilize limited amounts of non-protein nitrogen through rumen microbial activity, monogastric animals such as poultry cannot efficiently utilize urea and excessive intake may increase the risk of toxicity and metabolic disorders. This positive result is in line with organoleptic characteristics. Organoleptic observations in this study were used only as supporting indicators and not as definitive analytical evidence because odor intensity and texture perception may vary among panelists. Fishmeal from Boyolali has a more pungent fishy odor than other areas, as well as a dark brown color that is different from other samples which are generally light brown. The texture of fishmeal from Boyolali is also smoother, but a odor that is too sharp can be a sign of certain treatments or additives. Thus, both the results of urea tests and organoleptic observations showed a decrease in the quality of fishmeal from the area.

Moisture rate

Moisture content is an important parameter because it is directly related to the shelf life and growth potential of microorganisms. In pollards, the moisture content ranges from 8.2% to 12.9% (Table 2). According to common feed quality standards, moisture content in fishmeal is generally recommended to remain below 10–12%, while pollard is typically maintained below 12–14% to minimize microbial deterioration during storage. The highest score is found in the Trunk, while the lowest score is found in the Holy Tree. Most pollard samples were still within commonly accepted moisture ranges for feed ingredients, although several samples approached the upper limit. Evem though, higher moisture content can accelerate the occurrence of material damage, especially if storage is not done properly (Yahdiyani *et al*., 2025). Environmental factors such as temperature, humidity, packaging type, and storage duration may influence the physical quality of feed ingredients. High humidity can increase moisture absorption and microbial activity, whereas poor ventilation and inappropriate packaging may accelerate quality deterioration. In this study, samples were visually verified to be in acceptable physical condition prior to analysis. Most samples were stored in conventional feed sacks commonly used in commercial feed stores. Differences in geographical conditions among highland and lowland areas in Central Java may also affect storage temperature and humidity, potentially influencing feed quality characteristics. In fishmeal, the moisture content showed a wider variation, ranging from 7.9% in Ungaran to 20% in Purwodadi (Table 3). High values, especially in Jepara, Solo, and Purwodadi, show poor quality because high water content facilitates the growth of bacteria and fungi. Organoleptic results also support this finding, samples with high moisture content generally have a stronger fishy odor and a more moist texture (Ruslan *et al*., 2024), while samples with low moisture content are drier with a fishy odor typical of fish (Geng *et al*., 2024).

Contamination

The results of the contamination test showed that almost all pollard and fishmeal samples were not detected for contamination, so the quality was relatively safe (Tables 2 and 3). However, in pollard from Pati, storage pest infestation resembling mites or small storage insects was visually observed. Contamination assessment in this study was conducted through direct visual observation without microbiological enumeration or microscopic identification; therefore, the findings only indicate visible biological contamination. Storage pests may reduce feed quality through direct material consumption, increased humidity, physical damage, and facilitation of microbial growth. This biological contamination can reduce the quality of feed materials because ticks can damage the structure and nutrient content (Haryuni, 2024). Biological contamination also may reduce palatability and increase the risk of pathogen or mycotoxin exposure in livestock. The organoleptic results reinforce this finding, where pollard from Pati has a rather rough texture and a characteristic odor of wheat that is less fresh. This shows that the presence of storage pest infestations has reduced the quality of materials (Chandaragi *et al*., 2022). Although most areas are free of pollution, the presence of lice in one of the areas remains an indicator that quality control and storage still need attention. High environmental humidity, poor ventilation, prolonged storage, and loose packaging may contribute to pest infestation.

CONCLUSION

This study showed that 6 out of 17 regions (35.3%) indicated pollard adulteration based on phloroglucinol and float tests, while fishmeal adulteration with urea was detected in 1 region. Several samples also exhibited abnormal bulk density, high moisture content, and biological contamination, which may reduce nutritional quality, palatability, storage stability, and livestock safety. These findings highlight the importance of routine monitoring, proper storage management, and stricter quality control of feed ingredient distribution in Central Java.

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NOVELTY STATEMENT

This study pioneers a multi-method, field-deployable framework integrating phloroglucinol, float, bulk density, and urea assays to uncover previously underreported spatial heterogeneity in feed adulteration across Central Java. By bridging rapid diagnostic tests with organoleptic validation, it establishes a scalable and cost-effective paradigm for real-time surveillance of feed integrity in resource-limited production systems.

AUTHORS CONTRIBUTION

Cahya Setya Utama contributed to the conceptualization of the study, research design, supervision, and manuscript preparation. Bambang Sulistiyanto contributed to methodology development, data analysis, and critical revision of the manuscript. Nadya Marcelina Cinderawati contributed to data collection, laboratory analysis, and drafting of the manuscript.

Generative AI and AI-assisted technology statement

During the preparation of this manuscript, the authors utilized AI-assisted tools exclusively for language refinement and grammar correction. All content was carefully reviewed and revised by the authors, who assume full responsibility for the final version of the publication.

Conflict of interest

The authors have declared no conflict of interest.

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