CME LIVE OPEN ACCESS

Journal of
Epidemiology and Public Health

Research Article

ISSN: 3065-9078

Qualitative and Quantitative Evaluation on The Physico-Chemical Level of a Livestock Feed : The Case Of Cotton seed Cake

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Received: 2025 Jan 01 **Accepted:** 2025 Jan 20 **Published:** 2025 Jan 30

Abstract

Oilcake is a solid residue from the extraction of oil from seeds or oleaginous fruits. These are the by-products of the crushing «oil-making process». Livestock feeds are made up of a wide variety of raw materials, the mixture of which makes it possible to meet the nutritional needs of the animals. The choice of raw materials used in the composition of livestock feed is primarily conditioned by two factors : energy and protein content. Production in livestock territories in the Sahel raises a number of questions, including its quality, as it influences its nutritional value and biochemical composition, not to mention the risk of poisoning. Our objective was to assess the compliance of the meal consumed by the livestock. The analyses focused on thirty (30) samples taken from the production plants, made up of bags of cakes by determining : moisture, total ash, protein and Gossypol. The results obtained showed that all the cakes analysed were compliant with respect to proteins and Gossypol i.e. 100%, while 20% of the samples did not comply with the standards for moisture and ash. In view of these results, we recommend extending the qualitative and quantitative evaluation to other feeds intended for Livestock.

Keywords: Oilcake, Quality Control, Livestock Feed, Animals

1. Introduction

The creation of a real commercial feed production industry in Mali presents an interesting investment opportunity. The livestock sector in Mali, as a whole, contributes 12% to 15% of the Gross Domestic Product (GDP). In FCFA, the total value added of the sector has increased slightly since 1994. During dry periods, many farmers use a livestock feed called meal, which allows them to get through this period and maintain milk production. Oilcake is a solid residue obtained after the oil is extracted from oilseeds or oleaginous fruits. These are the co-products (by-products) of the crushing "oil-making process". Oilcakes are the 2nd most important class of food after cereals. Indeed, they represent the main source of protein in avian feed. Cottonseed, and even more so cottonseed meal, have long been used in animal feed. It is intended for animals can be whole, delinated (linters are a fuzz covering the shells), or more or less shelled. Whole cottonseed contains about 22% protein, 20% fat and 28% crude fibre (values expressed on dry terms) [1-5].

Feed production has great potential to establish an agro-industrial sector driven by modern cattle, sheep, goats, and poultry production. For a long time, Mali was a major centre in West Africa for cattle breeding. They are made up of a wide variety of raw materials, the mixture of which makes it possible to cover the nutritional needs of the animals for which they are intended. The choice of raw materials for the composition of livestock feed is primarily determined by two factors : energy content and protein content. Cereals are the preferred sources of energy in animal feed, while oilseed and protein meals are used for their high protein content [6,7].

The multiplicity of origins and varieties makes cottonseed a very variable product. Rich in fat and much richer in fibre than rapeseed and soybean (Figure 1 and 2), cottonseed is used to make rations for high-producing dairy cows that

are both high in energy and high in fibre, which explains its current popularity among North American dairy farmers. This observation is also valid in countries with large cotton productions, particularly Burkina Faso, Ghana and Mali. In 2019, the national herd was estimated at 12,111,128 cattle, 19,183,500 sheep, 26,486,240 goats, 584,184 horses, 1,144,336 donkeys, 1,241,093 camels, 86,182 pigs and 49,617,572 poultry animals, making Mali the 2nd largest livestock country in the ECOWAS (Economic Community of West African States) region, after Nigeria, and the 1st in the WAEMU. For several years now, livestock development policy has placed particular emphasis on the intensification of production and, consequently, on the development of integrated production systems, particularly agropastoral systems [5-8].

During the Covid-19 period, the price of cotton fell drastically in Mali. Cottonseed into livestock feed factories were left without raw materials. The consequence of this pandemic is that the oilcake market is exploding and the price of meat is rising. The production of the meal is governed by strict regulations that define its quality because it influences its nutritional value as well as its biochemical composition, not to mention the risks of poisoning in the event of indigestion. Currently, the development of modern production units, and consequently the sector's ability to meet growing demand, is limited by the lack of regular (year-round) supply of quality balanced animal feed. In the field of the food use of cotton products, two considerations dominate, on the one hand, their high nutritional value and on the other hand, the presence of gossypol. The use of cotton products in animal feed is limited by their content of gossypol, a yellow polyphenolic pigment contained in à free form in small glands present in particular in the kernel and seed coat. The bound forms are not toxic, but the free forms are toxic in the majority of animal species. The quality control of human or animal food is one of the operations that makes it possible to verify the safety of products and minimize any risk of contamination or poisoning. For this, controls are necessary for the consumption of the product. Through this, the food industries are always required to have their products checked for the purposes of voluntary regulation or to provide proof of the conformity of their products. It is in this context that this work was initiated, it consisted of carrying out a quality control study of meal samples at the National Health Laboratory [1-4].

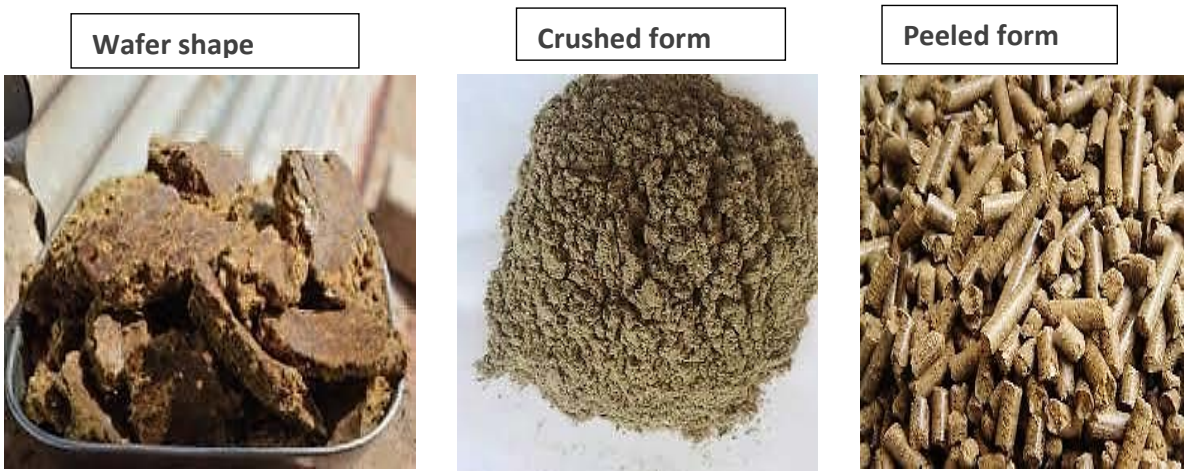

Figure 1: The Different Types Of Cotton By-Products Available on the Market [9]

Figure 2: Sunflower Meal (Left) and Rapeseed Meal (Right) [9]

2. Materials and Methods

2.1 Material

Several devices, solvents/reagents and devices are used to finally have results

Glass	Solvents/Reagents	Devices
Round bottom ball	Acetic acid	Agitator
Magnetic bar	Boric acid	Marine bath
Beaker	Hydrochloric acid Concentrate(reactive)	Analytical balance
Petri dish	Tartaric acid	Hollowed out empty
Graduated burette	Sulphuric acid	Distiller
Desiccator	Aniline, propanol-2	Oven at 105°C
Graduated test tube	Comprimé Kjeldahl	Furnace 550/600°C and 800/900°C
Volumetric flask	Ethanol	UV-Visible Spectrometer
Flask	Molybdate d'ammonium	
Aluminum foil	Hydrogen peroxide(Reactive)	
Filter paper	Methyl Red	
Pliers	Soda (1N)	

Table1: List of Equipment Used in the Analysis

2.2 Methods

2.2.1 Type and Period of Study

It was an analytical study based on the physico-chemical control of the meal received at the physico-chemical department of the National Health Laboratory. It took place from May to October 2022, a period of 7 months.

2.2.2 Sampling

We worked on the cakes received during the year 2022, which numbered 30 bags of 50 kg. The sampling in the different localities was carried out either by LNS staff during routine missions or by companies, the samples were sent directly to the LNS. Acceptance and codification were carried out by the reception service before carrying out the actual inspection. The different physicochemical parameters determined were Humidity, ash, crude protein assay, gossypol.

2.2.3 Determination of Humidity

We tare petri dishes and then weigh 5g of the sample into the tared petri dishes. Place the whole thing in an oven at 105°C for 5 hours. At the end of these 5 hours we brought out the boxes and proceeded to cool it in the dryer. We determined the weight of the dry extract after steaming on a precision scale [10,11].

Calculation Method : $H\% = \frac{P - P1}{P2} * 100$

P : The Weight Of The Petri Dish After Parboiling
P1 : The Weight Of The Empty Petri Dish
P2 : The Weight Of The Test Portion
H% : The Percentage Of Humidity

2.2.4 Determination of the Ash Content

We weighed 5g of the sample in a porcelain crucible that is marked and previously tared. Place the whole thing in an oven set at 650°C for 2 hours, then the sample is calcined in the oven at a temperature of 900°C for 15 minutes [11,12].

Calculation Method : $C\% = \frac{(P - P') * 2000}{100 - H}$

C% : Percentage of Ash
P : Weight After Incineration
P': Empty Weight of the Crucible
100-H : Dry Matter

2.2.5 Crude Protein Determination

We weighed 500 mg of the sample in a matras. We added two Kjeldahl catalyst tablets, 10 mL of 95% sulfuric acid and 15 mL of 30% hydrogen peroxide. Place the whole thing in the mineralizer with a temperature that gradually rises to 380°C. The mineralizer starts to Sound when the programmed time of 45 minutes is exhausted, at the end a clear and homogeneous greenish solution (mineralisat) should be obtained, After this first step, 50 mL of distilled water and 40 mL of caustic soda of concentration (1N) were added to the matra containing the mineralizer. The second step consisted of placing the matras, on the left side of the live distiller, then on the other right, a beaker containing 50 mL of boric acid was placed on the distillate recovery (light blue solution obtained). We started the rinse cycle by pressing the "M/A rinse" button on the machine, at the end of the cycle the distillate (non-protein nitrogen) is recovered when it reaches 150 mL in the beaker. Pour 3 drops of methyl red into the distillate and put a magnetic bar in place. Finally, we placed the beaker containing the distillate on a stirrer and with the graduated drip burette, H2SO4 (95%) at a concentration of 0.1N is poured during stirring, the distillate must be stirred until the solution is pink. The same processes were carried out with the white of the solution [11].

Calculation Method : $N = \frac{Ve - Vb \times 0{,}0014 \times 100}{M}$

P= N×6.25
N: Non-Protein Nitrogen
Ve = Distillate Volume Of The Sample
Vb = Volume Of The Distillate Of The White
M = Weight Of The Test Portion
P : Protein Level

2.2.6 Determination of Gossypol

Gossypol is generally extracted from the seeds of the cotton

Citation: Mody, C., Ousman, D., Niaboula, D., Noel, K. J., Abou, C.C. et al. (2025). Qualitative and Quantitative Evaluation on The Physico-Chemical Level of a Livestock Feed : The Case Of Cottonseed Cake. *J Epidemiol Public Health, 3*(1), 1-7.

plant of the genus Gossypium (family Malvacea). The name "gossypol" was coined by Marchlewski, who chose it from "gossyp (ium phen)ol" to indicate its origin and chemical nature (Figure 3) [13,14].

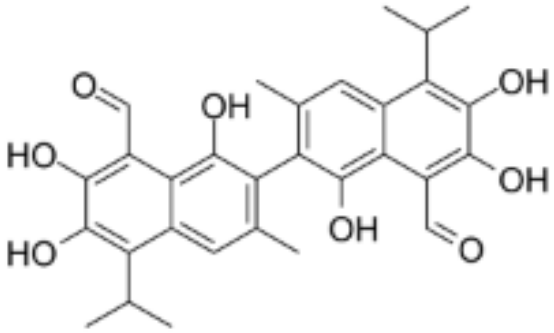

Figure 3: Gossypol Chemical Structure [15]

We put 250 mg of the sample in a 10 mL vial. Add to each vial 2 mL of the tartaric acid buffer solution, plus 1 mL of the ammonium molybdate-based solution A and 1 mL of the aniline-based solution B. Place in the incubator for 15 minutes at 70°C (accuracy of 2°C) then let cool and top up to 10 mL with the buffer solution. Starting with white, read the compounds obtained in ascending order of dilution with a visible UV spectrophotometer absorbances will be measured in the ranges of 300 to 520nm. Make a blank under the same conditions. The test portion for blank is 0.10 mL instead of 0.25 mL for samples.

3. Results

The analyses were carried out on thirty (30) samples, the results of the various parameters are detailed below.

3.1 Determination of Moisture Content and Total Ash

We determined the water content and total ash of Our samples

Designation Stilt	Humidity (%)	Ashes Total (%)	Compliance
Trt_1	9,20	5,50	Conformable
Trt_2	10,75	5,15	NC
Trt_3	9,20	6,78	Conformable
Trt_4	6,40	4,48	Conformable
Trt_5	3,20	3,75	Conformable
Trt_6	4,79	4,41	Conformable
Trt_7	4,80	4,50	Conformable
Trt_8	9,40	4,85	Conformable
Trt_9	4,90	5,04	Conformable
Trt_{10}	5,80	4,45	Conformable
Trt_{11}	5,38	4,01	Conformable
Trt_{12}	11,60	6,78	NC
Trt_{13}	7,17	7,54	NC
Trt_{14}	3,20	0,55	NC
Trt_{15}	9,76	4,43	Conformable
Trt_{16}	5,54	4,44	Conformable
Trt_{17}	4,19	5,00	Conformable
Trt_{18}	3,40	4,34	Conformable
Trt_{19}	5,00	4,60	Conformable
Trt_{20}	6,18	4,05	Conformable
Trt_{21}	8	6,08	Conformable
Trt_{22}	6	5,53	Conformable
Trt_{23}	5	4,84	Conformable
Trt_{24}	3,80	6,23	Conformable
Trt_{25}	3,80	5,40	Conformable

Trt_{26}	2,80	4,00	Conformable
Trt_{27}	4,4	4,81	Conformable
Trt_{28}	5,50	6,15	Conformable
Trt_{29}	7	5,80	Conformable
Trt_{30}	3,75	4,30	Conformable
Standards	<10	4 - 7	

Table 2: Results of the Analyses

NC : Non-compliant according to the standard used
TRT : cake The analysis of this table shows that some cakes had a higher than normal moisture content such as Trt_{2} (10.75%) and Trt_{12} (11.60%), which denotes that they cannot be kept for very long. As for the total ash, we found that the samples were not such as : Trt_{13} (7.54%) and Trt_{14} (0.55%). Apart from these samples mentioned above, everything else was compliant.

3.2 Determination of Proteins and Gossypol

Proteins and Gossypol have been determined and the results are in the table below

Designation Stilt	Protein content (%)	Gossypol	Compliance
Trt_{1}	20,68	Negative	Conformable
Trt_{2}	21	Negative	NC
Trt_{3}	20,58	Negative	Conformable
Trt_{4}	35	Negative	Conformable
Trt_{5}	25,55	Negative	Conformable
Trt_{6}	26,41	Negative	Conformable
Trt_{7}	28,43	Negative	Conformable
Trt_{8}	39,37	Negative	Conformable
Trt_{9}	27,43	Negative	Conformable
Trt_{10}	24,4	Negative	Conformable
Trt_{11}	22,13	Negative	Conformable
Trt_{12}	20,65	Negative	NC
Trt_{13}	26,25	Negative	NC
Trt_{14}	21,31	Negative	NC
Trt_{15}	27,82	Negative	Conformable
Trt_{16}	35,35	Negative	Conformable
Trt_{17}	29,56	Negative	Conformable
Trt_{18}	22,48	Negative	Conformable
Trt_{19}	28,78	Negative	Conformable
Trt_{20}	30	Negative	Conformable
Trt_{21}	39,35	Negative	Conformable
Trt_{22}	39,21	Negative	Conformable
Trt_{23}	21,35	Negative	Conformable
Trt_{24}	21,87	Negative	Conformable
Trt_{25}	24	Negative	Conformable
Trt_{26}	21,56	Negative	Conformable
Trt_{27}	29,56	Negative	Conformable
Trt_{28}	40	Negative	Conformable
Trt_{29}	27	Negative	Conformable
Trt_{30}	22,73	Negative	Conformable
Norm	20-40	_	

Table 3: Distribution of Samples Analyzed by Protein and Gossypol

NC : Non-compliant according to the standard used
TRT : Crab This table shows that out of the 30 samples analyzed, we found that trt2, Trt12, Trt13 and Trt14 did not comply with the total protein test according to the reference used which is the food codex. The tests of our samples at gossypol did not reveal any cases of non-compliance so they were all compliant

4. Discussion

In view of the results we obtained, the humidity level gave an appreciation of the water content present in the material. When the cakes are exposed to the open air, they quickly capture moisture. Almost all of our samples analyzed had a content that was in accordance with the standard used except for the Trt2 and Trt12 (10.75 and 11.60%) had a moisture level higher than the standard so their preservation will be a bit tricky. A high moisture content, the cakes will be sensitive to interactions with microbes and the environment. The high humidity level of our non-compliant samples can be explained by the storage conditions. We observed that the ash obtained after incineration of the samples provided results that varied between 0.55% and 7.54%. Among the intrinsic factors acting on the shelf life of food, particularly onions, the dry matter content plays a very important role [10,11].

For the determination of proteins, we found a 100% compliance rate on all the samples analyzed and they vary between 20.58% and 41%. This difference depends on the quality of the cotton, the production process and the storage time of the meal. The protein level is high in the seed and very high in the cakes. The biological value of a protein for a given species depends on its composition of essential amino acids. By taking milk or whole egg proteins (C.U.D. = 100) as a reference, it has been possible to establish a scale of value for proteins of vegetable or animal origin. According to H. CALVET, in 1977 reported in his study on cottonseed oil that American authors and numerous studies carried out in this field, have shown that cotton proteins have a good biological value which would put them, admittedly, at a lower level than milk proteins, but on a par with those of peanut meal and above the proteins of copra sesame meal or alfalfa flour. The limiting factor of cotton protein is lysine because lysine is very quickly altered by heat, the value of the protein will depend on the temperature at which the meal is heated during oil extraction. During the gossypol analyses, we had a 100% compliance rate on all the samples analysed. This confirms that the risk of poisoning or mortality in animals is low or even non-existent because depending on the method used there is no trace of gossypol. According to the study carried out by H. CALVE 1973, the proportion of both forms varies according to the products analysed. In Egypt, out of 8 samples of cottonseed prepared from unhulled seed, there was an average of 1.36 g per cent of total gossypol and 0.18 g per cent of free gossypol. The effects of gossypol in ruminants are still relatively poorly understood. The various animal species are very sensitive to this toxicant. Rabbits, pigs and poultry are much more sensitive than ruminants. Doses likely to cause accidents : in < Generally speaking, the susceptibility of animals varies within the same species according to many factors (age, general condition of the animals, habituation, etc.). Detoxification of seeds and cakes can be done by heat treatment. Gossypol can also be eliminated chemically using a solvent, or by inactivating free gossypol by the addition of a metal salt : the incorporation of iron in the form of iron sulphate improves the tolerance of pigs and poultry to gossypo [12-15].

5. Conclusion

The present study focused on the analysis of certain cakes received in 2022 at the food and beverage quality control department of the National Health Laboratory (LNS). During this study, we analyzed the conformity of the meal consumed in Mali. This analysis focused on a number of parameters which are humidity, ash, Proteins and gossypol. The varions samples analysed by the LNS food quality control department during the period almost complied with the physico-chemical quality standards. The consumption of these cakes does not present a danger to Animals. As the industrialisation of the oilcake sector is growing rapidly in Mali, it is imperative that such controls be held regularly in these industries. Cottonseed meal contains a toxic pigment that is like a natural insecticide whose consumption can cause health problems or even mortality. It is necessary to analyze these cakes to improve the quality of the products and to push industries to respect the dosage of constituents recommended by international organizations.

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