Sustainable systems

Determinations of protein content and proximate analysis of castor cake for protein supplementation in poultry feed

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ABSTRACT

The world population is rapidly increasing rapidly increasing world population is demanding more food. Addressing this demand requires growth in agricultural outputs including eatable animals (livestock, poultry, and fish) and, their products. However, these animals by themselves need food, which is usually competing with human food. Besides, some animals and human foods are industrially competitive, Which makes feeds less available and costly. As a result, the cost of animals and animal products is drastically increasing. Thus, to address these tradeoffs either optimize the consumption of the feeds or looking for alternative feeds is required for poultry feeding. This study focuses on determinations of protein content and proximate analysis of castor cake for protein supplementation in poultry feed. Cake left after solvent extraction was detoxified with a chemical method (lime treatment 10gm/kg cake) followed by a physical method (autoclaving at 15 psi for 30 min) and the ricin level was quantified with UV spectroscopy. The result showed that insignificant ricin was found in the castor. The Proximate analysis of the cake was a Moisture content of 9.1% carbohydrate 5.5% fat content 24.3% Ash content 8.3% Fiber content20.3%.

Keywords: Detoxification, Ricin, protein content, proximate analysis

INTRODUCTION

The economy of Ethiopia is mainly based on mixed agriculture (crop and livestock production together) (Mekuria and Mekonnen 2018). The poultry sector is one of the most subsectors of the rural area's economy. The productions give society a source of food and money. According to the statistical agency 2020a, Ethiopia has 49 million poultry (Morgan and Choct 2016). The poultry industry uses a largely traditional production system, where the production rate is low and the supply system is mainly based on yard scavenging. This traditional system has failed to meet the needs of society as the country's population has been increasing annually (Adugna, Hotel, and Ababa 2019). This brings the poultry sector to a modern production system to meet the needs of society. Modern poultry production uses a balanced diet in poultry feed. However, balanced diets consist of various conventional food sources such as corn, wheat, and various seeds which are expensive and competitive for humans. As the population increases daily, nutritionists are finding other unconventional feed sources for partial or complete feed replacement. Thus, the unconventional food sources Castor bean meal (castor cake) and cassava by-products are the major sources of protein and carbohydrates respectively (Ashenafi 2016).

Castor cake obtained after castor bean extraction accounts for about half the weight of castor and is one of the more unconventional sources of protein for poultry feed (Mondal, 2019).It is used as a protein supplement due to its high crude protein content compared to traditional sources. However, it is restricted in poultry feed due to anti-nutritional factors such as ricin (M Bera and Das 2020). In the old days, the anti-nutrition factor carried castor cake as a fertilizer. This is because the cake treat is more expensive than other food sources. Recently, the protein crop source has become competitive with humans and has become more expensive for its use as poultry feed. By applying various detoxification methods such as physical, chemical, and biological, inexpensive compared to the cost of crops, castor cake can be used as a protein supplement in poultry feed (M Bera and Das 2020).

MATERIALS AND METHODS

Raw Materials And Chemicals

Castor seed was the main raw material used for the experiment. The castor seed was used in the preparations of protein supplementation of the feed. several chemicals such as ethanol, calcium hydroxide, potassium bromide, sodium hydroxide, sulphuric acid, hydrochloric acid, phenolphthalein, potassium cyanide, and distilled water were used.

Equipment And Instruments

For this experiment, the following equipment and instruments were used. A muffle furnace, laboratory oven, beaker, volumetric flask, conical flask, measuring cylinder, desiccator, balances, grinder, mortar and pestle, titration unit, crucibles, magnetic stirrer, mixer, centrifuge, rotary evaporator, UV spectrophotometer was used.

Methodology

The methodology used for this research was a general method. In the treatment and preparation of the raw materials, synthesis, and characterization of raw materials and the feedstuff different procedures were performed. The details of the procedures were given in the following section.

Raw Material Preparation

Castor seed preparation

The castor beans must undergo some steps of processing before the extraction procedure. The castor seed was bought from Debre Berhan town. Firstly, the purchased castor seed was cleaned manually to remove impurities present in them.Itwassun-dried for one-dayto keep the moisture content within the standards for oil extraction, It was oven dried at 60°C for 2 hours. The dried seed was deshelled to remove the upper cove.Finally, the deshelled seed was ground using mortar and pestle to reduce its size

Castor Oil extraction

The solvent extraction method as described by (Akpan et al .2006) was adopted for the extraction of the oil and Ethanolwas used as a solvent.100g of the sample was placed in the thimble and inserted in the center of the soxhlet extractor. 300ml of normal Ethanol was poured into a round bottom flask. The soxhlet washeated at 78°C and as the solvent boiled, the vapor rises until the condenser was at the top of the extractor. The condensate solvent then drips into the thimble, which contains the castor sample to be extracted. The extracted product then seeps through the thimble's pores and flows back down into the round bottom flask. The extraction was preceded until 3hrs repeatedly. After that, the castor cake was removed from the tube and dried in the oven. The castor cake was weighed again to determine the amount of oil that had already been extracted. The mixture of the solvent and the extracted oil wasseparated by using a rotary evaporator.The yield of the oil was calculated using equation 2.1 as follows.

$$\text{yield } (\%) = \frac{\text{weight of oil}}{\text{weight of the seed}} * 100\% \quad \ldots\ldots 2.1$$

Figure 0-1 solvent extraction

Detoxification of Castor Cake

The detoxification process was done according to the method (He et al. n.d.).one kg of the cake was treated with 10 g limeand, autoclaved the sample at 15 psi for 30min.The treatedcastor cake was oven dried at 60 ^{0}C for two hrs.The cakewas stored in a dry place.

Figure 0-2 A) untreated and, B) Treated castor cake

Characterization of Raw Materials

Quantification of ricin by UV spectrophotometer

The amount of ricin in castor cake was done according to the method proposed by (Journal 2014).1gm of the detoxified cake was dissolved with 5 ml of dilute H_2SO_4 (at PH 3.8). The dissolved sample was centrifuged at4000rpmthe absorbance of the supernatant was measured byUV752 visible spectrophotometer at wavelength279a nm using a quartz cell. The system was calibrated with the bovine serum albumin (BSA) standard.The concentrations of the ricin in sample the waswereterminedusing beer lambert law with the molar absorption coefficient of ricin 93, 900 L $mol^{-1}cm^{-1}$.

A = ƐLc ………………………………………………………………………….2.2

WhereA is the amount of light absorbed for a particular wavelength by the sample

Ɛ is the molar extinction coefficient

L is the distance covered by the light through the solution

C is the concentration of the absorbing species

Proximate analysis

For the proximate analysis of raw material and feeds, the Association ofOfficial Analytical Chemists recommended methods (AOAC)were used (Verem et al. 2021).Proximate parameters (carbohydrate, fats, protein, fiber, and ash) of the raw material and the prepared feed were determined according to the method proposed. The nitrogen content of the samples was determined by the Kjeldahl method. 6.25 factor was used to convert it to crude protein multiplied by the nitrogen value obtained. The weight difference methods were used to determine moisture and ash content levels while the crude fat of the feed was determined by the soxhlet method using petroleum ether as solvent. The carbohydrate content was determined by calculation using the following method:

%Total Carbohydrate = [100 − % (Protein + Fat + Moisture + Ash + Fiber)] (Verem et al. 2021)

RESULTSAND DISCUSSION

Raw material preparation

After deshelling, its upper cover, 736 g castor seed was obtained from 1kg which was 73.60% of the original castor seed used. The moisture content of the prepared castor seed was measured as 7%.The result of the moisture content of the castor seed waswithin the range of 5-12% of the standard used in the oil extraction process.

Oil Extraction

The dried castor seed was used for extracting the oil, and about 273.8g of oil was obtained from 736g of castor seed after the rotary evaporation of solvent and oil. The percentage ofoilwas calculated based on equation 2.1. The resultwas about 37.2% of the mass of the castor seed used. This result falls within the range of the percentage oil content up to 40% of castor seed as reported by (Madhabendu Bera, Sciences, and Sciences 2020). A total of 462.2 g cake was obtained from 736 g castor seed.It indicates that castor seed has a great potential for poultry feed after detoxification of the ake.

Quantification of ricin concentration in castor cake

The amount of ricin found in castor cake sample was evaluated according to equation2.2. During the absorbance measurement, the UV vis spectroscopy gives a result of 0.18 absorbances .Based on the beer lamber law the concentration found in the cake was 1.6*10-7L/mol. The result showed that ricin was almost not found in the sample.Itindicates that the selected method eliminated the toxin of the seed, and it was efficient to detoxify ricin from castor cake as reported by (MadhabenduBera, Sciences, and Sciences 2020).In addition to UV result, no mortality of broiler chickens observed during feeding of the meal., itindicates that the ricin toxicity was completelty eliminated from the cake as small amounts of ricin dosage kill animals reported by (Akande, Odunsi, and Akinfala 2016)

Raw material characterization

Proximate analysis of raw materials

The determinations of the proximate constituents were necessary for the nutritional level of poultry feeds frequently consumed in the poultry sector. The proximate result for the final product waspresented in table 3.2 below.

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Table 0-1 proximate analysis of castor cake in percentage

Moisture content	9.1
carbohydrate	5.5
Crude protein	32.5
fat content	24.3
Ash content	8.3
Fiber content	20.3

The moisture content (MC) determines the amount of water in the samples.Too much amount of moisture content in feeds affects the physical and chemical properties of the feed which relate to its freshens, suitability for storage of the feed over a long period, and mold formation which affects the health of the poultry (Oladimeji et al. 2022). The result in table 3.2 above indicates that the prepared castor cake an acceptable moisture content of 10% the standard of poultry feed moisture content reported by (Ofori, Amoah, and Arah 2019).

Carbohydrates are an essential dietary source of energy for poultry.It makes up the largest nutrient in the poultry diet it gives a high level of energy production (Ofori, Amoah, and Arah 2019). Improper carbohydrate level affects energy production, which affects the digestion system, body weight loss, and health problem (Sharipova et al. 2017). The conventional method in the above table showed that the prepared cake has a carbohydrate source of 5.5% which indicates the prepared cake has also a minimum energy source

An optimum amount of protein in poultry could be used for egg production, carcass growth, and feather development. While the improper balance of protein in the diet can cause improper egg size, and weight loss and affects the work of kidneys (Oladimeji et al. 2022). as shown in above table 3.2 the prepared poultry feed has 32.5% which was the best result according to the standard of protein requirements for poultry.

The level of fat in the blend affects palatability and the overall physical quality of the feed whether in the mash or pelleted diets (Ofori, Amoah, and Arah 2019). All fats should be blended from a strictly controlled range of sustainable ingredients to produce a consistent fatty acid profile, giving good digestibility and handling characteristics. as shown in the above table 3.2 the prepared cake has a fat content of 24.3% which is an optimum fat content according to the standards required for fat for poultry.

The ash component of the feed describes the inorganic content of the feed mainly minerals. These critical nutrients are requiredin specific amountsin poultrydietsstrong bone, blood clotting, enzyme activation, and eggshell formations (Proximate Analysis of Selected Commercial Broiler Feeds in Makurdi metropolis, North-Central Central Nigeria 2020).To improve the quality of feed a suitable level of ash content is required in poultry feed. As shown in the table above the prepared poultry feed has an ash content of 8.3% which fits the standards required for ash for poultry.

The fiber content in feeds affects the digestion system. to keep the digestion system to normal way an optimum fiber content is required for feeds. as shown in the above table the prepared poultry feed has a fiber content of 20.3% which was the standard of fiber requirements for poultry as stated by (Ofori, Amoah, and Arah 2019).

CONCLUSION

In this study, non-competitive to human food and industrial input, cost-effective nutrient source was prepared from the seeds of castor for the supplementation of protein in poultry feed.the protein content and the proximate analysis result showed that castor cake have a protein content of Crude protein 32%. as the protein content of the cake comes in the standerd range of protein required for poultry feed it can be used as a paricial supplementations of protein in poultry feed preparation.

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