# THE POTENTIAL OF NIGERIAN BENTONITE IN THE FORMULATION OF ANIMAL FEED

**Okoye, Ngozi Franca**
*Department of Biochemistry, University of Port Harcourt, Rivers State. Nigeria*
Email: *francaokoye1@yahoo.com*

## *Abstract*

*The quest for import substituton for improvement of dwindling Nigerian economy calls for formulation of goods with local raw materials. This study was aimed at formulating animal feed using a natural bentonite found in Nigeria and also determine the effects of the bentonite formulated feed on some biochemical parameters of wistaralbino rats (Rattusrattus). A total of 45 rats with average weight of 100g were divided into 5 groups including the control group. Four groups were fed with feed containing bentonite, while the control group was fed standard commercial feed for 21 days. The rats were sacrificed from each group after week one, week two, and week three respectively. The blood was obtained for the determination of alanine transaminase (ALT) and aspartate transaminase (AST). The results indicated that the rats fed with the natural bentonite formulated feed showed significant weight increase with the highest weight increase observed on the third week of feeding. There was no significant change in the level of ALT and AST indicating that there was no adverse effect on the rat's liver. Thus, the Nigerian natural bentonite had great potential for animal feed formulation. It was, therefore, Recommended for utilization in the formulation of animal feed.*

***Keywords:*** *Animal feed formulation, Nigerian bentonite*

## Introduction

Bentonite clay is an absorbent aluminium phyllosilicate impure clay consisting mostly of montmorillonite. The absorbent clay was given the name bentonite by Wilbur C. Knight in 1898, after the Cretaceous Benton Shale near Rock River, Wyoming in America. There are different types of bentonite, each named after the respective dominant element that it contains, such as potassium (K), sodium (Na), calcium (Ca), and aluminum (Al). Bentonite usually forms from weathering of volcanic ash, most often in the presence of water. For industrial purposes, two main classes of bentonite exist: sodium and calcium bentonite (Hosterman and Patterson, 1992).

Numerous studies have established that bentonite provides many excellent health benefits for man and animals. Almost all natural clays have value in promoting human health. Some may be consumed, others are best used only externally, and some are best reserved for industrial purposes. Clays in general, provide a wide array of benefits for humanity, whether for the body, in the garden, or for industrial use (Marek, 1981; Churg and Wiggs; 1985, Fan and Aw, 1989).

Bentonite has been utilized as a useful material in both high-roughage and high-concentrate based diets of ruminants due to its ability to absorb toxic products from digestion and lowering the accumulation of toxic substances in tissues (Huntington et al., 1977; Fenn and Leng, 1989; Varadyova et al., 2003). Danica (2011) stipulated that the negative ionic charge of the bentonite clay is the reason it is so helpful in detoxifying the body. A negative charge allows the clay to attract only substances that have positive charges, such as toxins, harmful bacteria, pesticides, heavy metals, and pathogens, without leaching away any beneficial elements. This clumping action prevents toxic molecules from passing through the walls of the intestines and entering the blood stream. Together with the clay the toxins are eliminated harmlessly from the body through the kidneys (Wu and Khera, 1990; Okoye and Nyimone, 2015). Little wonder bentonite is a key ingredient found in many colon cleansing and detox products.

Experts believe montmorillonite is the mineral that gives bentonite its beneficial qualities. But, bentonite also contains magnesium and 67 other trace minerals. The properties of these particles, as well as their placement within the bentonite molecule, give the clay its healing effects, including its all-important negative charge (Gens and Alonso, 1992; Walzet al, 1998; Danica, 2011).

Bentonite is widely used as feed additives because of its properties and accessibility (Wu and Khera, 1990; Grant and Philip, 1998; Hassen et al, 2003). The properties of bentonite are derived from the crystal structure of the smectite group, which is an octahedral alumina sheet between two tetrahedral silica sheets. Variations in interstitial water and exchangeable cations in the interlayer space affect the properties of bentonite and thus the commercial uses of the different types of bentonite. Bentonite has been prescribed as a bulk laxative, and it is also used as a base for many dermatologic formulas (Kolta, 1976; Hosterman and Patterson, 1992; Gitipour et al, 1997).

Profitability of a production business depends on a number of factor, including price and availability of its raw materials. There are basically two types of animal feed, namely, fodders and forage. Fodders refer to feed given to animals rather than that which they forage for themselves. They include hay, straw, silage, compressed and pellet feeds, oils and sprouted grains (Grant and Philip, 1998; Hassen et al, 2003).

Aspartate transaminase (AST) is a pyridoxal phosphate (PLP)-dependent transaminase enzyme (EC2.6.1.1). AST catalyzes the reversible transfer of an α-amino group between aspartate and glutamate and, as such, is an important enzyme in amino acid metabolism. AST is found in the liver, heart, skeletal muscle, kidneys, brain, and red blood cells. Alanine transaminase (ALT) is a transaminase enzyme (EC2.6.1.2). ALT is found in plasma and in various body tissues, but is most common in the liver. Serum AST and ALT levels are commonly measured clinically as biomarkers for liver health. These enzymes have become increasingly important in clarifying the etiology, pathonogenesis as well as diagnosis of a number of diseases associated with the different organs in which they are present or concentrated (Watkins and Kaplowitz, 2006; Okoye et al, 2012).

This work was motivated by the desire to heed the Government’s call to produce made in Nigeria products using local content. Therefore the objective of this study was to formulate animal feed using a natural bentonite found in Nigeria and also determine the effects of the bentonite formulated feed on some biochemical parameters such as the liver markers AST and ALT of wistaralbino rats (*Rattusrattus*).

# MATERIALS AND METHODS

The natural calcium bentonite clay used for this work was obtained from Anambra State in Nigeria. Reagent kits were bought from Randox Laboratories Ltd. Ardmore, Diamond Road, Crumlin, Co. Antrim, United Kingdom BT29 4QY. A total of forty five male and female wistarabino rats (*Ratusrattus*) were obtained from the small animal holding unit of the Department of Biochemistry, University of Port-Harcourt, Choba, Nigeria. They were housed at room temperature in clean metabolic cages which were cleaned of wastes twice daily at 12-hour interval.

The rats were maintained on normal rat diet and water and they were allowed to acclimatize for seven days after which they were randomly divided into five groups. Rats in group one (9 rats) served as the control and were fed the standard commercial feed and distilled water twice daily at 12-hour interval for 21 days. The rats in Group two to five (36 rats) were fed the animal feed formulated with different concentrations of bentonite clay. The weight and size of the rats were monitored.

The animals in the five groups were sacrificed in days 7, 14, and 21 days. This was done by cardiac puncture with the animal under anaesthesia (chloroform) in a desiccator. The blood collection was done immediately and the blood samples were stored in a lithium heparin sample containers. The blood was centrifuged at 3000 rotations per minute for 3 minutes and the blood plasma were separated and used for analysis following the instructions as stipulated in the user manual from the reagent's kit.

## STATISTICAL ANALYSIS

All data were expressed as mean ± standard deviation. Statistical analysis was performed using SPSS version 20.0. The data were analyzed using one-way analysis of variance (ANOVA) where p values <0.05 were considered as significant.

# RESULTS

Data on the effect of bentonite feed on weight of wistar rat (*Rattusrattus*) are shown on Table 4.1.

***Table 4.1:*** *Effect of bentonite feed on weight of wistar rat (Rattusrattus).*

| Test Feed (100%) | Initial weight (g) | 7 days (g) | 14 days (g) | 21 days (g) |
|---|---|---|---|---|
| Control (standard commercial feed) | 100.00 ± 0.00 | 146.00 ± 4.71 | 158.00 ± 16.49 | 163.00 ± 11.82 |
| 1% bentonite feed | 102.00 ± 0.10 | 156.00 ± 11.09 | 166.00 ± 11.80 | 178.00 ± 11.90 |
| 2% bentonite feed | 100.00 ± 0.00 | 160.00 ± 10.00 | 175.00 ± 11.00 | 182.00 ± 10.00 |
| 3% bentonite feed | 105.00 ± 0.01 | 183.00 [a] ± 14.00 | 188.00 ± 0.09 | 199.00 [a] ± 10.00 |
| 4% bentonite feed | 102.00 ± 0.01 | 185.00 [a] ± 12.00 | 193.00 ± 10.00 | 201.00 [a] ± 12.00 |

Results are means of three determinations ± Standard deviation. [a] Significant difference was observed at $p<0.05$.

The *in vivo* effect of the bentonite feed on albino rat alanine transaminase (EC 2.6.1.2) at 37$^{o}$C, pH = 9.8 expressed in IU/L is shown in Table 4.2.

Table 4.2: *In vivo* effect of bentonite feed on albino rat alanine transaminase (EC 2.6.1.2) at 37$^{o}$C, pH = 9.8 expressed in IU/L.

| **/100g of bentonite feed** | **7 days (IU/L)** | **14 days (IU/L)** | **21 days (IU/L)** |
|---|---|---|---|
| Control (0.00) | $11^{a} \pm 1.00$ | $11 \pm 0.00$ | $12 \pm 0.00$ |
| 1.00 | $11 \pm 1.00$ | $12 \pm 0.00$ | $13^{a} \pm 2.00$ |
| 2.00 | $11 \pm 1.00$ | $12 \pm 0.00$ | $13^{a} \pm 1.00$ |
| 3.00 | $12 \pm 0.00$ | $12 \pm 1.00$ | $12 \pm 0.00$ |
| 4.00 | $12 \pm 0.00$ | $12 \pm 1.00$ | $13^{a} \pm 1.00$ |

Results are means of three determinations ± Standard deviation. [a]Significant difference was observed at $p<0.05$.

The *in vivo* effect of Nigerian bentonite feed on albino rat aspartate transaminase (EC 2.6.1.1) at 37$^{O}$C, pH = 9.8 expressed in IU/L is shown on Table 4.2.

Table 4.3. *In vivo* effect of Nigerian bentonite feed on albino rat aspartate transaminase (EC 2.6.1.1) at 37$^{O}$C, pH = 9.8 expressed in IU/L

| /100g of bentonite feed | 7 days (IU/L) | 14 days (IU/L) | 21 days (IU/L) |
|---|---|---|---|
| Control (0.00) | $32^{a} \pm 5.00$ | $32 \pm 5.00$ | $32 \pm 0.00$ |
| 1.00 | $31 \pm 0.00$ | $32^{a} \pm 4.00$ | $32^{a} \pm 2.00$ |
| 2.00 | $31^{a} \pm 4.00$ | $32 \pm 2.00$ | $32 \pm 0.00$ |
| 3.00 | $32 \pm 0.00$ | $32^{a} \pm 4.00$ | $32 \pm 0.00$ |
| 4.00 | $32 \pm 0.00$ | $32 \pm 0.00$ | $33 \pm 0.00$ |

Results are means of three determinations ± Standard deviation. Significant difference was observed at $p<0.05$.

# DISCUSSION

Table 4.1 shows an improvement in the weight gained by the albino rats that were fed with bentonite feed compared to those fed with the standard commercial feed. The weight increase was concentration and time dependent. The highest weight increase was observed on the third week of feeding with the highest dose of 4% bentonite feed (201.00 ± 12.00 compared to control 163.00 ± 11.82). This increase could be due to increased feed retention time, thus subjecting the nutrients in the feed to enzymatic action for longer period of time or it could be due to the action of the bentonite on the enhanced digestibility of certain nutrients.

Recent studies involving the use of clay as dietary supplements suggest that some clay products may have direct beneficial effects on animal performance, body weight, egg size and life expectancy. They not only contribute to the animal feed performance but also have nutritive contribution by providing trace elements required for optimum nutrition of farm animals, improved protein metabolism, enhanced enzymatic activity and increased nutrient utilization and absorption (Hedayati et al, 2014).

A long-term (28 weeks) toxicity study with rats indicates that the level of calcium montmorillonite as high as 2% does not result in over toxicity as determined by zoo technical parameters, gross, histological pathology, haematological parameters, or clinical chemistry. Consequently, it is considered that there is no corcern in terms of safety for consumers of food products from animal feed diet containing bentonite (Afriyier-Gyawu et al, 2005; Okoye and Nyimone, 2015; Okoye and Obi, 2016).Studies have shown that commercial clay additives have been used to prevent caking and improve the physical properties of animal feeds (James and Zartman, 2011).

Mycotoxins frequently *contaminate* animal and human foods, such as peanut (*Arachishypogaea*), corn (*Zea mays*), rye (*Secalecereale*), and cotton (*Gossypium hirsutum*) seed. In developed countries with effective regulations and food testing programmes, mycotoxin contamination mostly affects animals. In developing countries, mycotoxins are a significant health risk to humans and animals (Bennett and Klich, 2003; Murphy et al 2006).

However, animal feeding studies have demonstrated that the clay additives, Novasil plus, Astra Ben 20A, Na-bentonite, zeolite, and sepiolite can effectively reduce or prevent toxicity caused by feed contaminated with *Aspergillus* mycotoxins, such as AfB1 (Pimpukdee et al, 2004; Bailey et al, 2006; Fairchild et al, 2008).

It has also been observed that dietary supplements of bentonite decreased microbial degradation of feed protein and increased ruminant synthesis of microbial protein, duodenal flow of amino acids and growth of wool in sheep with normal ruminant microbial population (Bennett and Klich, 2003). The result obtained from this study is also in agreement with the observation of Huntingdon et al (1977) who noted that bentonite has the ability to absorb toxic products from digestion and lower the accumulation of toxic substances in tissues of animals.

The liver performs many vital metabolic and homeostatic functions such as detoxification. It also has hemolytic, storage and excretory functions (Okoye et al 2012). The results from this investigation also showed that there was no significant change in the level of ALT and AST of the rats fed with the bentonite feed as compared to the control, indicating that there was no adverse effect on the rat’s liver.

# CONCLUSION

This study investigated the potential of Niegerian bentonite in animal feed formulation by comparing performance of rats fed with standard commercial animal feed and animal feed formulated with Nigerian bentonite. The results indicated that the rats fed with the bentonite feed showed significant weight increase with the highest weight increase observed on the third week of feeding .The result also showed that there was no significant change in the level of ALT and AST indicating that there was no adverse effect of the bentonite feed on the rat’s liver. This investigation has shown that the Nigerian natural bentonite has great potential in animal feed formulation.

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