NUTRITIVE VALUE OF DIFFERENTLY PROCESSED MANGO SEED KERNEL (Local Variety (Kanbiri) and mixed Samples) MEAL IN BROILER DIETS

BY

ABDULLAHI IDRIS

DEPARTMENT OF ANIMAL SCIENCE

FACULTY OF AGRICULTURE

AHMADU BELLO UNIVERSITY, ZARIA.

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DECLARATION

I hereby declare that the work in this thesis entitled, **"Nutritive Value of Differently Processed Mango Seed Kernel (Local Variety (Kanbiri) and Mixed Samples) Meal In Broiler Diets"** has been performed by me in the Department of Animal Science, under the supervision of Prof. J.J. Omage and Prof. T.S.B. Tegbe. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this Thesis was previously presented for another Degree or Diploma at any University.

______________________ _______________

Abdullahi, Idris Date

CERTIFICATION

This Thesis entitled **NUTRITIVE VALUE OF DIFFERENTLY PROCESSED MANGO SEED KERNEL (Local Variety (Kanbiri) and mixed Samples) MEAL IN BROILER DIETS** by IDRIS ABDULLAHI, meet the regulations governing the award of degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation

Prof. J. J. Omage — Date

Chairman, Supervisory Committee

Prof. T. S. B. Tegbe — Date

Member, Supervisory Committee

Prof. G. S. Bawa — Date

Head of Department,

Department of Animal Science,

Ahmadu Bello University,

Zaria.

Prof. A. A. Joshua — Date

Dean, Post-graduate School,

Ahmadu Bello University,

Zaria.

DEDICATION

I humbly dedicate this work to God Almighty who has given me strength to complete this work and to my parents, Alhaji Abdullahi Umar Maidariya, Hajara Abdullahi and Ferere Abdullahi for giving me the best education. May Allah reward them abundantly. I also dedicate this work to my wife and dear children, Auwal Idris, Ammar Idris and Nasiba Idris for their patience and perseverance during the period of this work.

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ABSTRACT

Two feeding trials were conducted to evaluate the nutritive value of local variety (kanbiri) and mixed samples of mango seed kernel meal (MSKM) processed by soaking and boiling on the proximate composition level of ant nutritional factors, performance and hematology of broiler chickens. The results indicated that kanbiri processed by boiling reduced the anti nutritional factors levels such as phytate, tannine, cyanide and oxalate by 84.44%, 9.43%, 77.98% and 24.0%. In the mixed samples boiling reduced phytate by 74.19%, and Tanin 47.06% compared to control. In the first experiment which lasted for eight weeks two hundred and twenty five (225) day old broiler chicks with average initial weight of 40.00g were randomly allotted to five dietary treatments with three replicates of 15 birds each in completely randomized design. The experimental diets consisted of soaked and boiled local variety (Kanbiri) and mixed sample mango seed kernel MSK inclusion in broiler starter diets at 25% dietary level to replace maize in a control diets to make 5 treatments designed as T1, T2, T3, T4 and T5 for mixed samples at the starter and finisher phases. The result of the first trial shows that final weight at the starter and finisher phases were significantly (P<0.05) higher in the control group (486.67g and 1500g respectively) compared to all other treatments. The average water intake was significantly (P<0.05) higher in birds fed soaked mixed samples of MSK based diets (T4) than the other treatments. There were no significant differences in the feed intake, weight gain, feed to gain ratio, feed cost per kg gain. In the finisher phase, the final weight was significantly (P<0.05) higher in the control group T1 compared to bird fed soaked mixed samples of MSK based diet (T4) but was similar to all other treatments. The feed to gain ratio, water intake, feed cost per kg gain were significantly better in the control group compared to T3, T4 and T5 but were similar to the values in T2. The carcass analysis shows that there were significant differences in dressed weight, liver, shank and spleen across the treatments. There were no significant differences in all other

parameters measured. Hematological evaluation shows that the total protein was significantly (P<0.05) higher in the control group (T1) and (T2) compared to other treatment. There were no significant differences in other hematological parameters and differential blood count across the treatment. In the second trial 270 day old chicks were randomly allocated to six dietary treatments with three replicate of 15 birds each in a completely randomized design. The diets consisted of varying levels of (0, 20, 40, 60, 80 and 100%) of soaked local (kanbiri) variety of mango seed kernel representing treatment 1,2,3,4,5 and 6 respectively. The result of the starter phase of the second trial shows that the final weight was significantly (P<0.05) higher in T1 and T2 compared to other treatments. The weight gain was significantly (P<0.05) higher in T1 compared to other treatment. The feed to gain ratio in the feed cost per kg gain were significantly (P<0.05) poorer in (T6) compared to other treatments and the finisher phase, the final weight and weight gain were significantly (P<0.05) higher in T1 compared to T3, T4, T5 and T6, but similar to T2. The feed intake was significantly (P<0.05) higher in T2 compared to T5 but similar to other treatments. The feed to gain ratio was significantly (P<0.05) better in treatment one compared to other treatments. The feed cost per kg gain was significantly (P<0.05) lower in T1 and T2 compared to other treatment. Hematological parameters shows that total protein was significantly (P<0.05) higher in T1 compared to T3, T4 and T5 but similar to T2 and T6. There were no significant differences in other hematological parameters measured across the treatment. The result indicated that local (kanbiri) variety of MSK processed soaked enhanced the performance of broiler chickens when included at 60% level also (kanbiri) processed by soaking had no adverse effect on the health status of the birds. The second experiment indicated that (kanbiri) processed by soaking and included at 20% level gave performance characteristics similar to that of control indicating that local (kanbiri) variety can be included as a substitute for maize at 20% level without deleterious effect on the health status of the bird.

TABLE OF CONTENTS

Pages

Declaration.. ii

Certification.. iii

Dedication.. iv

Acknowledgement.. v

Abstract.. vi

Table of Content.. viii

List of tables.. xi

CHAPTER ONE

1.0 Introduction.. 1

1.1Aims and Objectives.. 2

CHAPTER TWO

2.0 Review of Literature.. 3

2.1 Origin and distribution of mango.. 3

2.2 Common names of mango.. 4

2.3 Description of Mango.. 4

Size.. 4

Canopy.. 5

Roots.. 5

Flowers.. 5

Leaves.. 6

Fruits.. 6

Seeds.. 7

2.4 Nutrients and Anti-nutrients composition of mango seed and fruit.. 7

2.5 Economic importance / uses of Mango.. 13

2.5.1 Uses of mango seed.. .. .. .14

2.5.2 Animal fodder/feed material.. 14

2.5.3 Timber.. .. .. .15

2.5.4 Fruit.. 15

2.5.5 Flavoring/spice.. 16

2.5.6 Nut/seed.. 16

2.5.7 Leaf vegetable.. .. .. .16

2.6 Utilization of Alternative energy sources for maize in poultry production.. 16

CHAPTER THREE

3.0Materials and Methods.. .. .. .20

3.1 Sources and Processing of the Mango Seed Kernel (Msk) Meal.. .. .. .20

3.1.1 Soaking of Mango Seed Kernel for 72 Hours.. 20

3.1.2 Boiling of Mango Seeds Kernel.. 20

3.2 Determination of the proximate composition of Mango Seed Kernel.. 20

3.2.2 Determination of Anti-Nutritional Factors in Mango Seeds Kernel.. 20

3.3 EXPERIMENT 1.. 23

3.3.1 Experimental Site.. .. .. .23

Starters phase 23

3.3.2 Preparation of Experimental diets.. 23

3.3.3 Experimental Design and Management of Experimental Birds.. 25

Finishers phase .. .. .25

3.3.4 Experimental Diets.. 25

3.3.5 Experimental Design and Management of Experimental Birds.. .. .. .28

3.3.6 Parameters Measured.. 28

3.3.7 Carcass Analysis.. 28

3.3.8 Heamatological Evaluation.. 28

3.4 Experiment 2: 29

Starters phase: 29

3.4.1 Preparation of Experimental diets.. 29

3.4.2 Experimental Design and Management of Birds.. 29

Finishers phase: .. .. .32

3.4.3 Preparation of Experimental Diets.. 32

3.4.4 Design and Management of Experimental Birds.. 32

3.4.5 Parameters Measured.. 32

Carcass Analysis.. 32

Heamatological Evaluation.. .. .. .32

Statistical Analysis.. .. .. .32

CHAPTER FOUR

4.0 Results.. .. .. .33

4.1 Effects of processing Methods on the Levels of Anti-nutritional Factors in Local variety (Kanbiri) and Mixed Samples of mango seed kernel: 33

Experiment 1: 34

4.2 Performance of Broiler Starter Fed MSKM… 34

4.3 Performance of Broiler Finishers Fed MSKM.. .. .. …. 34

4.4 Carcass Characteristics of Broiler Finisher Fed MSKM.. .. .. … 37

4.5 Apparent Digestibility Evaluation of Broiler Finisher Fed MSKM 37

4.6 Haematological Evaluatiion of Broiler Finisher Fed MSKM 40

Experiment 2: 40

4.7 Performance of Broiler Starter Fed Graded Levels of MSKM.. 40

4.8 Performance of Broiler Finisher Fed Graded Levels of MSKM…. 40

4.9 Carcass Characteristics of Broiler Finisher Fed Graded Levels of MSKM.. 47

4.10 Digestibility Evaluation of Broiler Finisher Fed Graded Levels of MSKM 47

4.11 Haematological Evaluatiion of Broiler Finisher Fed Graded Levels of MSKM .. .48

CHAPTER FIVE

5.0 Discussion 54

Experiment 1:

5.1 effects of processing Methods on the Levels of Anti-nutritional Factors in Local variety (Kanbiri) and Mixed Samples of mango seed kernel 54

5.2Performance of Broiler Chicks and Finishers Fed MSKM 55

5.3 Carcass Characteristics of Broiler Finishers Fed MSKM 55

5.4 Digestibility Evaluation of Broiler Finishers Fed MSKM.. 56

5.5 Haematological Evaluation of Broiler Finisher Fed MSKM.. 56

Experiment 2:

5.6 Performance of Broiler Chicks and Finishers Fed Graded Levels of MSKM.. .. .57

5.7 Carcass Characteristics of Broiler Finishers Fed Graded Levels of MSKM.. .. .. .57

5.8 Digestibility Evaluation of Broiler Finishers Fed Graded Levels of MSKM... 58

5.9 Haematological Evaluatiion of Broiler Finishers Fed Graded Levels of MSKM.. ..58

CHAPTER SIX

6.0 Summary / Conclusion.. .. .. .60

6.1 Summary.. 60

6.2 Conclusion.. .. .. .60

6.3 Recommendations.. 61

References.. .. .. .62

List of Tables

2.1 Proximate composition of mango seeds.. .. .. … 10

2.2 Amino acid profile (g/100 g of protein) of mango seeds.. 12

2.3 Vitamins contents (mg\100g) of mango seeds.. .. .. .13

3.1: Proximate composition of differently processed Mango-Seed Kernels (MSK).. 24

3.2: Effects of Processing Methods on the Levels of Anti-nutritional Factors in Local variety (Kanbiri) and Mixed Sampel of mango seed kernel.. .. .. .25

3.3: Composition of Broiler starter diets (0-4 weeks) Experiment 1.. .. .. .27

3.4: Composition of Broiler Finisher diets (5-8 weeks) Experiment 1.. 30

3.5 Composition of Broiler Starter Diets Experiment 2.. .. .. .34

3.6 Composition of Broiler finisher Diets Experiment 2.. .. .. .35

4.1 Performance of Broiler Starter Fed MSKM.. …. 40

4.2Performance of Broiler Finisher Fed MSKM.. …. 41

4.3 Carcass Characteristics of Broiler Finisher Fed MSKM.. …. 43

4.4 Apparent digestibility of Broiler Finisher.. .. .. …. … .. .. .44

4.5 Haematological Profile of Broiler Finisher Fed MSKM.. …. 47

4.6 Performance of Broiler Finisher Graded Levels of MSKM.. .. .. .48

4.7 Performance of Broiler Finisher Graded Levels of MSKM 49

4.8 Carcass Characteristics of Broiler Finisher Graded Levels of MSKM.. .. .. .50

4.9 Apparent Digestibility of Broiler Finisher Graded Levels of MSKM.. 51

4.10Haematological Profile of Broiler Finisher Graded Levels of MSKM.. 53

CHAPTER ONE

1.0 INTRODUCTION

As climate is fast changing the production of maize cannot keep pace with its demand for food and industrial uses such as ethanol and bio-fuel production. In poultry production, energy is used for the provision of body heat, maintenance, growth, and production. Cereal grains such as maize has remained the major energy source in poultry diets. It is high in starch which can be easily digested by birds but relatively low in protein and deficient in amino acids such as lysine, methionine, and tryptophan. The mineral contents of cereals notably sodium, calcium and available phosphorus is also very low (Smith, 1997).

F.A.O. (1997) reported that the recommended daily consumption of animal protein should be 56g per day per person, but unfortunately Nigerians cannot meet this requirement due to the high cost of the farm animal products. Christopher *et al*. (1997) reported that Nigerians consume only 15g of protein per day. Raising broiler chickens is one of the quickest ways of meeting the animal protein need of the populace due to their high rate of feed efficiency (Aduku and Olukosi, 1990).

Feed is the most important input in a profitable poultry production. It accounts for 70 – 80% of total cost of production (Bello, 1984; Ogundipe, 1987; Kehinde *et al*., 2006). This necessitates the use of non-conventional feed ingredients and the search for other feed resources that are not expensive (Farinu *et al.,* 2006). Non-conventional feed stuff offers the best alternative in our environment for reducing the feed cost of meat and animal products (Dafwang *et al.,* 2001).

Nigeria and most other developing countries are experiencing animal protein intake deficiencies. Oyawoye (1989) reported that there is protein deficiency gap for which careful attention is necessary to prevent metabolic diseases in Nigerian citizens. Nigeria's population is increasing rapidly and this indicates the need to strategize action and device means of improving the consumption of animal protein intake of the average citizen through poultry production particularly broiler chickens because of their rapid growth rate and short generation intervals.

Mango (*Mangifera indica*) belongs to the cashew family *Anacardiaceae*. It is a large ever green tree that can reach 15 to 30m in height (Cangolly, 1959). Diarra *et al*; (2010) reported that Mango-Seed Kernels is a good source of soluble carbohydrates. Its protein is comparable to that of maize. It is abundant, available and cheap compared to maize. This research investigated the different processing methods for local variety of mango seed kernel (Kanbiri) along with other mixed variety and their use as a feed resource in broiler chicken diet.

1.1 OBJECTIVES OF THE STUDY

The objectives of this study are to;

i. determine the effect of soaking and boiling on the proximate composition of kanbiri a local variety of mango seed kernel and other mixed varieties.

ii. determine the growth performance and carcass values of broiler chickens when fed with diets containing mango seed kernel meal.

iii. evaluate the nutrient utilization of broiler chickens when fed diets containing mango seed kernel meal.

iv. evaluate the effect of feeding diets containing mango seed kernel on the haematology and serum chemistry of broiler chickens.

v. determine the bioeconomics of using mango seed kernel as feed component in broiler diets.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.0 Origin and distribution of mango

Mangos belong to the genus *Mangifera* of the family Anacardiaceae. The genus *Mangifera* contains several species that bear edible fruit. Most of the fruit trees that are commonly known as mangos belong to the species *Mangifera indica*. The other edible *Mangifera* species generally have lower quality fruit and are commonly referred to as wild mangos (Alcorne *et al.,* 1999). They further reported that Mango has become naturalized and adapted throughout the tropics and subtropics. Much of the spread and naturalization has occurred in conjunction with the spread of human populations, and as such, the mango plays an important part in the diet and cuisine of many diverse cultures.

There are over 1000 named mango varieties throughout the world, which is a testament to their value to mankind. Mango is a common garden tree throughout the tropics. Mangos prefer a warm, frost-free climate with a well-defined winter on dry season. Rain and high humidity during flowering and fruit development reduces fruit yields (Bally, 1999).

Alcorne *et al.* (1999) stated that the genus *Mangifera* originated from tropical Asia, with the greatest number of species found in Borneo, Java, Sumatra, and the Malay Peninsula. The most-cultivated *Mangifera* species, *M. indica* (mango), has its origins in India and Myanmar. Mango is now cultivated throughout the tropical and subtropical world for commercial fruit production, as a garden tree, and as a shade tree for stock. In the Pacific region, all mangoes were introduced from other parts of the world.

The earliest recorded introductions into Hawai‘i were prior to 1825; however, most introductions to the Pacific islands have occurred over the past 100 years. Few other *Mangifera* species are found in the Pacific. *Mangifera gedebe*, *M. minor*, and *M. mucronulata* are found in the Solomon Islands and *M. minor* in Micronesia, but these either do not fruit or the fruit is inedible (*Bally,* 1999)

2.2 Common names of mango

The different names for mango around the world today reflect the cultures and languages spoken by people who grow them. Many of the names have common derivations, reflecting the origins and spread of the mango tree along with the spread of human communities. The more popular names for mango fruit in the Pacific and Asia are listed below with the countries or languages from which they come. Pacific island names as stated by Bally*,* (1999)

idele (Palau)

kangit (Chuuk, Pohnpei)

mago (Niue, Samoa, Tuvalu)

manako (Hawai‘i)

The common names and varieties of mango in northern part of Nigeria are: Kanbiri, Bakin Aku and Yarcamaro (all in Hausa and language).

2.3 Description of Mango

Size

Mangos are long-lived evergreen trees that can reach heights of 15–30 m (50–100 ft). Most cultivated mango trees are between 3 and 10 m (10–33 ft) tall when fully mature, depending on the variety and the amount of pruning. Wild, non-cultivated seedling trees often reach 15 m (50 ft) when found in favourable climates, and they can reach 30 m (100 ft) in forest vegetaion. The trees can live for over 100 years and develop trunk girths of over 4 m (Bally, 1999).

Canopy

Mango trees typically branch 0.6–2 m above the ground and develop an evergreen, dome-shaped canopy. Variability in canopy shape and openness occurs among varieties and with competition from other trees. Mangos grown in heavily forested areas branch much higher than solitary trees and have an umbrella-like form.

Roots

The mango has a long taproot that often branches just below ground level, forming between two and four major anchoring taproots that can reach 6 m (20 ft) down to the water table. The more fibrous finer roots (feeder roots) are *Mangifera indica* (mango) found from the surface down to approximately 1 m (3.3ft) and usually extend just beyond the canopy diameter (Bally, 1999). Distribution of the finer roots changes seasonally with the moisture distribution in the soil.

Flowers

Mango flowers are born on terminal inflorescences (panicles) that are broadly conical and can be up to 60 cm long on some varieties. Inflorescences usually have primary, secondary, and tertiary pubescent, cymose branches that are pale green to pink or red and bear hundreds of flowers (Bally, 1999). Chia *et al*., (1997) and Bally *et al*., (2006) stated that the mango has two flower forms, hermaphrodite and male, with both forms occurring on the same inflorescence. The ratio of hermaphrodite to male flowers on an inflorescence varies with variety and season and is influenced by the temperature during inflorescence development. Hermaphrodite flowers are small (5–10 mm, 0.2–0.4 in) with four to five ovate, pubescent sepals and four to five oblong, lanceolate, thinly pubescent petals. Only one or two of the four to five stamens that arise from the inner margin of the disc are fertile. The single ovary is born centrally on the disc with the style arising from one side. The disc is divided into a receptacle of four or five fleshy lobes that forms the nectaries. The male flowers are similar to the hermaphrodite flowers but are without the pistil, which has been aborted (Bally, 1999).

Leaves

The leaves are simple, without stipules, and alternate, with petioles 1–12 cm (0.4–5 in) long. The leaves are variable in shape and size but usually are oblong with tips varying from rounded to acuminate. Leaf form differs among varieties but is more consistent within a variety. However, a range of leaf sizes can be seen on a single tree. Matur.e leaves are dark green with a shiny upper surface and glabrous lighter green lower surface. New leaves emerge in flushes (episodic growth spurts) of 10–20 leaves. Leaves emerge green, turning tan-brown to purple during leaf expansion and then gradually changing to dark green as the leaves mature. The colour of the young, expanding leaf differ with variety and can be from light tan to deep purple; which can be used as a distinguishing character among varieties.

Fruit

Mango fruit is classed as a drupe (fleshy with a single seed enclosed in a leathery endocarp). Fruits from different varieties can be highly variable in shape, color, taste, and flesh texture. Fruit shapes vary from round to ovate to oblong and long with variable lateral compression. Fruits can weigh from less than 50 g (0.35 lb) to over 2 kg (4.4lb). The fruit has a dark green background color when developing on the tree that turns lighter green to yellow as it ripens. Some varieties develop a red background colour at fruit set that remains until the fruits ripen. In addition to the background color, many varieties also have an orange, red, or burgundy blush that develops later in the fruit development, when the rind is exposed to direct sunlight. The mesocarp is the fleshy, edible part of the fruit that usually has a sweet and slightly turpentine flavor. When ripe, its colour varies from yellow to orange and its texture from smooth to fibrous.

Seed

Mango varieties can be classified as having either mono-embryonic or poly-embryonic seed embryos. In mono-embryonic varieties, the seed contains only one embryo that is a true sexual (zygotic) embryo. Mono-embryonic seeds are a cross between the maternal and paternal (pollen) parents (Bally, 1999). Fruit from mono embryonic seedlings will often vary from the parent trees, so propagation by grafting is used to produce true-to-type mono-embryonic trees. Poly-embryonic seeds contain many embryos, most of which are asexual (nucellar) in origin and genetically identical to the maternal parent. Poly-embryonic seeds also contain a zygotic embryo that is the result of cross-pollination. The mono-embryonic seedling usually has less vigour than a nucellar seedling for use as a rootstock. In some varieties this is reversed and the zygotic seedling is the most vigorous (Bally, 1999). The occurrence of off-types in orchards is often attributed to use of zygotic seedlings

2.4 Nutrients and anti-nutrients composition of mango seed and fruit

Mango is rich in a variety of phyto-chemicals and nutrients that qualify it as a model "super fruit", a term used to highlight potential health value of certain edible fruits. The fruit is high in prebiotic dietary fiber, vitamin C, polyphenols and carotenoids (Nutritiondata.com, 2008).

Mango fruit contains essential vitamins and dietary minerals. The antioxidant vitamins A, C and E comprise 25, 76 and 9% of the Dietary Reference Intake (DRI) in a 165 g content. Vitamin B6 (pyridoxine, 11% DRI), vitamin K (9% DRI), other B vitamins and essential nutrients such as potassium, copper and 17 amino acids are at good levels. Mango peel and pulp contain other phytonutrients, such as the pigment antioxidants - carotenoids and polyphenols - and omega-3 and -6 polyunsaturated fatty acids. The edible mango peel has considerable value as a source of dietary fiber and antioxidant pigments (Rocha *et al.,* 2007; Ajila and Prasada, 2008). Contained within the peel and pulp are rich contents of polysaccharides as fiber sources, especially starch and pectins (Iagher *et al*., 2002; Berardini, 2005).

Antioxidants of the peel and pulp include carotenoids, such as the provitamin A compound, beta carotene, lutein and alpha-carotene (Gouado *et al*., 2007). Mahattanatawee et al. (2006) and Singh *et al.,* (2004) reported that polyphenols such as quercetin, kaempferol, gallic acid, caffeic acid, catechins, tannins, and the unique mango xanthone, mangiferin are present in mango.

Contents of these phytochemicals and nutrients appear to vary across different mango species (Dercival *et al*., 2006; Rodinguez *et al*, 2006; Rocha et al ., 2007). Up to 25 different carotenoids have been isolated from mango pulp, the densest content for which was beta-carotene accounting for the yelloworange pigmentation of most mango species (Chen *et al.,* 2004). According to Barreto *et al.,* (2008), peel and leaves also have significant content of polyphenols, including xanthones, mangiferin and gallic acid. The mango triterpene, lupeol is an effective inhibitor in laboratory models of prostate and skin cancers (Saleem *et al.,* 2004; Nigam *et al.,* 2007; Chaturvedi *et al.,* 2008; Prasad *et al.,* 2008).

An extract of mango branch bark called Vimang, isolated by Cuban scientists, contains numerous polyphenols with antioxidant properties *in vitro* (Rodeiro *et al.,* 2006) and on blood parameters of elderly humans (Pardo-Andreu *et al.,* 2006).

Mango seed is fair in crude protein, high ether extract and low in fiber (Fowomola, 2010). The table below shows the proximate composition of mango seed.

Table 1 Proximate composition of mango seeds.

Parameters	**Composition (%)**
Crude protein	10.06 ± 0.12
Crude oil	14.80 ± 0.13
Ash	2.62 ± 0.025
Crude fibre	2.40 ± 0.01
Carbohydrate	70.12 ±1.34
Energy content	453.92 ± 4.32 KJ/100 g

Source: Fowomola (2010).

It has been reported that mango seed is very rich in glutamate, and poor in methionine (Fowomola, 2010). Among the essential amino acids, Fowomola (2010) reported that leucine has the highest value (8.40 g/100 g of protein). This is followed by arginine which has the value of 5.17 g/100 g of protein. The table below shows the amino acid profile of mango seed. Phenylalanine/Tyrosine had the highest amino acid value while lysine has the lowest value and it is the limiting amino acid in mango seed.

It has been shown that mango seed contained 15.27 (IU) vitamin A; (1.30 mg/100 g) vitamin E; (0.59 mg/100 g) Vitamin K; (0.08 mg/100 g) Vitamin B1; (0.03 mg/100 g) Vitamin B2; (0.19 mg/100 g) Vitamin B6; (0.12 mg/100 g) Vitamin B12 and (0.56 mg/100 g) Vitamin C. Mango seed is richer in vitamins and calcium than cassava (Bede, 2010) which is almost half of that of mango seed. Fowomola (2010) reported that mango seed contained sodium (21.0 mg/100 g), potassium (22.3 mg/100 g), calcium (111.3 mg/100 g), magnesium (94.8 mg/100 g), iron (11.9 mg/100 g), zinc, (1.1 mg/100 g) and copper (0.1 mg/100 g).

Table 2 Amino acid profile of mango seeds (g/100 g of protein).

Amino acid	**Quantity**
Lysine	3.13
Alanine	6.40
Histidine	2.31
Cysteine	2.30
Arginine	5.17
Valine	3.80
Aspartate	6.33
Methionine	1.04
Threonine	2.04
Isoleucine	3.23
Serine	2.93
Leucine	8.40
Glutamate	13.00
Tyrosine	3.17
Proline	3.00
Glycine	3.50
Phenylalanine	4.46

Source: Fowomola (2010).

Table 3. Vitamins contents of mango seeds (mg\100g).

Vitamins	Amount (mg\100 g)
A	15.27 (IU)
E	1.30
K	0.59
B1	0.08
B2	0.03
B6	0.19
B12	0.12
C	0.56

Source: Fowomola (2010).

Mango seed has been reported (Fowomola, 2010) to contain alkaloid (0.01 ± 0.0 mg/100g), tannins (1.03 ± 0.01 mg/100 g), phytate (1.44 ± 0.01 mg/100 g), cyanide (0 mg/100 g), saponin (0.04 ± 0 mg/100 g) and oxalate (1.49 ± 0.01 mg/100 g). Its trypsin inhibitor activity was found to be 18.42 ± 2.54 TIU/mg protein. Sherry mango seed does not contain cyanide which shows that it is less toxic when compared with cassava (Bede,2010).

Tannins are aromatic compounds containing phenolic groups. They interact with salivary proteins and glycoproteins in the mouth and render the tissues astringent to taste (Howes, 1953). Astringency gives tannin the medicinal value in preventing diarrhoea and dysentery and for controlling haemorrhage (Sollman, 1957; Jones, 1965). Furthermore, tannins protect plant against dehydration, rotting, damage by animals and pathogens. When they are polymerized, insoluble protective barrier is formed which prevents microbial attack (Stumpf and Conn, 1981). Therefore they can be applied to wounds as protective coating. Bichel and Bach (1968) had earlier reported that the symptoms of continued intake of tannin include gastritis as well as irritation and oedema of the intestine. Glick and Joslyn (1970) have also reported that feeding 0.5% of tannic acid decreased nitrogen retention and caused 5% mortality in rats.

It has been reported by Bressani *et al.,* (1983) that tannins exhibit their toxicity effects by forming protein-tannin complexes through multiple hydrogen binding between their hydroxyl groups and carboxyl groups of protein peptide bonds of proteolytic enzymes in the gastrointestinal tract. Savage *et al.,* (1964) reported that phytate depressed the growth of chicks fed with phytate-casein diet by forming complex with zinc thereby making the later unavailable.

Omosaiye and Cheryan (1979) also reported that, phytate form complex with protein by the actions of cations, usually calcium, zinc or magnesium which act as a bridge between the negatively charged protein carboxyl groups and the metals. The report of Chen *et al.,* (1934) had shown that the minimum lethal dose of hydrogen cyanide taken by mouth for man to be between 0.5 and 3.5 mg/kg body weight. Symptoms of hydrogen cyanide include peripheral numbness, light-headedness, mental confusion, stupor, cyanosis and convulsion were reported by survivors (Halstrom and Moller, 1945). Oxalate forms complex with calcium thereby making it unavailable when fed into animals and more so high oxalate diets can increase the risk of renal calcium absorption (Osagie and Eka, 1988).

In addition, dietary oxalate has been known to complex with calcium,magnesium and iron leading to the formation of insoluble oxalate salts and resulting in oxalate stone (Wardlaw and Kessel, 2002).

Saponins have been shown to possess both beneficial and deleterious properties (Price *et al.,* 1987; Oakenful and Sidhu, 1989). These authors indicated that saponines have cholesterol lowering effect and cytotoxic properties which is permeabilization of the intestine. Although some saponins have been shown to be highly toxic under experimental conditions, acute poisoning is relatively rare both in animals and man (Osagie and Eka,1988). Some alkaloids for example potato alkaloid (solanine) cause gastrointestinal upsets and neurological disorders, especially when taken in excess of 20 mg/100 g sample (Osagie and Eka, 1988).

Trypsin inhibitors are low molecular weight proteins which form complexes with trypsin thereby reduced it`s proteolytic activity which in turn reduced the availability of amino acids, reduced growth and pancreatic enlargement (Liener, 1989). Low levels of anti-nutrients observed in mango seed suggested that it is less toxic and it will not adversely affects livestocks if incorporated in their feeds. The works of Ravindran and Sivakanesan (1996), Farag (2001) and Agunbiade and Olanlokun (2006) had earlier shown that soaking and boiling,autoclaving for 30 min plus irradiation up to 20 kGy and roasting and boiling drastically reduced the antinutrional factors present in mango seed kernels respectively, thereby improved their nutritional qualities.

Mango seed has been reported to be a nutritional promising seed because of its high levels of carbohydrate and oil (Fowomola, 2010)

2.5 Economic importance / uses of Mango

2.5.1 Uses as anti-oxidant

Mango seed is very rich in calcium and magnesium. The presence of antioxidant vitamins such as vitamin C, E and A suggests that mango seed could be used as an alternative source of these vitamins. Antioxidant vitamins have been reported to reduce oxidative processes which are known to be vital in the initiation of arthrosclerosis (Steinberg *et al.,* 1989). The results of mineral assayed by Fowomola, (2010) showed that mango seed is very rich in calcium and magnesium. Calcium is essential for regulating the heartbeat, conducting nerve impulses, stimulating hormone secretions, clotting of blood, building and maintenance of healthy bones (Medindia 2008). According to Michael (1996), Magnesium is a critical co-factor in more than 300 enzymatic reactions in the human body. In addition, injectable magnesium sulphate has been extensively used in the treatment of high blood pressure, acute heart attacks, chronic cardiovascular disease, heart arrhythmias, diabetes, asthma, chronic fatigue syndrome and pre-eclampsia and eclampsia of pregnancy.

2.5.2 Uses of mango seeds

Alcoholic beverages made from mangos include wines and liquors made in Australia and India. Specialty teas are occasionally flavored with fragrant mango flowers (Campbell *et al.,* 2002).

In addition to mango's food value, it has also been used for its medicinal value. In Samoa, a bark infusion has been a traditional remedy for mouth infections in children (pala gutu), and in Tonga, infusions of leaves of mango, the orange (*Citrus sinensis*), and other species are used to make a potion to treat relapse sickness (kita) (Bally *et al.,* 2006). In India, a drink made from unripe mango fruit is used as a remedy for exhaustion and heat stroke. Half-ripe fruit eaten with salt and honey is used for a treatment of gastro-intestinal disorders, bilious disorders, blood disorders, and scurvy. Ripe mangos are a rich source of vitamin A, and are used to treat vitamin A deficiencies such as night blindness.

Diabetes has been treated with a drink made from the infusion of fresh mango leaves. Dried mango seed ground into flour is used to treat diarrhea. Diarrhea and throat disorders are treated by gargling bark extracts mixed with water. In India, fruit sap has been used to treat the pain of bee and scorpion stings (Ridgway *et al.,* 2001). Bally (1999) reported that many of the traditional Indian medicinal uses of mango involve eating unripe fruit. It should be noted that unripe fruit contains a lot of the toxic sap that when eaten in excess can cause throat irritation, indigestion, dysentery, and colic.

2.5.3 Animal fodder/feed material

Livestock graze on mango leaves and eat fallen fruit. The leaves can be toxic if consumed in large quantities. Seeds and by-products of processing fruit have been used to feed cattle, poultry, and pigs. Mango kernels could be used as feed for livestock. Mango (*Mangifera indica* L.) kernel is a good source of soluble carbohydrate (Saandy *et al.,* 1980 and Dairra and Usman, 2008). Its protein is comparable to that of maize, but it has higher fat than maize (Saandy *et al.,* 1980). However, mango kernel is reported to contain some tannin which exerts antinutritive effects in poultry and man (Jansmans *et al.,* 1995 and Tequia, 1995). Boiling has been reported to be an effective method of tannin reduction. Recently, Dairra and Usman (2008) replaced 20% of dietary maize in broiler chickens with raw or boiled mango kernel meal and observed no significant differences in performance between the control and the boiled kernel meal diets.

2.5.4 Timber

Mango timber when properly seasoned has been used in furniture, for carving, as wall and floor paneling, and utensil manufacture. The timber is gray-brown, often with a pink tinge

(Bally, 1999). It is coarse-textured hardwood that is easy to work and finishes well. The timber breaks down rapidly if exposed to the elements without preservation treatment.

2.5.5 Fruit

Mangos are predominantly grown for their fruit, which is mostly eaten ripe as a dessert fruit. Mature green mangos are also eaten fresh or as pickles. Green eating varieties are distinguished from others by their sweet, non-starchy, non astringent flavor at the green-mature stage of fruit development. Mature green eating mangos are eaten in several ways throughout the world. In Thailand they are sliced or grated in fresh salad, pickled (ma mung dong), soaked in water and sugar (ma mung chaien), salted and dried (ma mung khem), sliced in vinegar or fish sauce (ma mung plawa arn), or eaten as a crunchy fruit (Bally, 1999). In many places, like in Samoa, the fruits are eaten green because someone else will eat them if one waits for ripening or because fruit fly larvae are not yet developed. Fresh mangos are processed and preserved into a wide range of products including pulps, juices, frozen slices, dried slices, pulp (fruit leather), chutneys, jams, pickles, canned in syrup, and sliced in brine. Mangos are a highly nutritious fruit containing carbohydrates, proteins, fats, minerals, and vitamins, in particular vitamin A (beta carotene), B1, B2, and vitamin C (ascorbic acid) (Bede, 2010). As the fruit ripens, concentrations of vitamin C decrease and glucose, fructose, and sucrose concentrations increase Bally, (1999). Mangos make a significant seasonal contribution to diet of many Pacific islanders that primarily have a starch-based diet.

Flavoring/spice

Mango purees and essences are used to flavor many food products such as drinks, ice creams, wines, teas, breakfast cereals, muesli bars, and biscuits.

2.5.6 Nut/seed

In parts of India the seed is eaten as a boiled or baked vegetable or ground into a starchy flour.

2.5.7 Leaf vegetable

Young leaves, still rose or bronze coloured, can be boiled to render them edible. Although the cooked leaves hold their shape and are attractive, their resinous flavor is an acquired taste. Some varieties are more suitable for eating in this manner (Martin *et al.,* 1998).

2.6 Utilization of Alternative energy sources for maize in poultry production

Several agricultural by-products namely brewers dry grain, cassava and yam peals including cocoa pod husks and mango kernels, that are crop residues usually wasted, have been tested in trials with broilers (Teguia 1995; Teguia *et al*., 2004) as an energy source, to cut down cost of production due to the high cost of maize. Leaves and forages traditionally used for other purposes or even wasted have also been tested, namely sweet potato leaves, bitter leaves, perennial peanuts and *Desmodium* spp. (Teguia *et al.,* 1993; Teguia *et al.,* 2002). In the various studies, the dietary maize component was replaced on a weight basis. Thus, the nutrient composition and digestibility of the test diets differed from that of the control diet. Generally, the feedstuffs under study contained less energy and more protein than did maize. Clearly, the outcome of the studies cannot be unequivocally interpreted in terms of nutrients affecting growth performance. However, the results are important from a practical point of view.

Ground mango kernels (*Mangifera indica L*) could be used to replace up to 200 g of maize per kg of broiler starter diet, but with some adverse effect on weight gain and feed consumption (Teguia, 1995). Increasing the amount of mango kernels in the diet induced a linear depression of feed consumption. Enhanced growth was observed in birds fed with a grower-finisher diet in which 65 g of maize/kg diet was replaced by cocoa husks (Teguia, 1982). However, inclusion of 195 g cocoa husks/kg diet depressed performance. High inclusion levels of the two crop residues are contraindicated by the presence of anti-nutritional substances.

The presence of tannins in mango kernels has been reported by Göhl (1982). Tannins are responsible for an astringent taste of the feed that induces a lower feed intake due to reduced palatability (Butler *et al.,* 1984; 1986). Tannins may also combine with proteins, including enzymes in the digestive tract and thereby negatively affect the digestibility of proteins (Jansman *et al.,* 1995) and carbohydrates, thus reducing the chick's growth rate, the efficiency of feed utilisation and the availability of metabolisable energy of the diet (Rostango, 1972). As reported by Laroussilhe (1980), boiling, roasting or soaking could eliminate the astringent taste of mango kernels, thus improving taste and acceptance by the growing birds. Bressani (1993), El-Tahey Shehata (1992) and Iyer *et al.,* (1980) also reported the reduced concentration of tannins in grains treated with boiled water. Thus, it follows that the impact of either cocoa husks or mango kernels versus maize on growth performance of broilers may become beneficial if these crop residues are properly pre-treated to eliminate the influence of tannins.

Theobromin present in cocoa husks could be responsible for the declining growth rate of broiler chickens when the husks are fed at high inclusion levels. Alternatively, increasing the proportion of cocoa husks may result in deterioration of the amino acid profile of the diet. Indeed, adding synthetic amino acids to diets containing cocoa husks improved animal production efficiency (Branckaert *et al.,* 1967; 1973). The negative effect of cocoa husks on poultry growth may also be explained by the high fibre content of the diets when it has a high dietary inclusion level. An increase in dietary fibre lowers the metabolisable energy content of the diet and may depress the efficiency of feed utilisation. More feed is then required to cover the energy requirement of the bird, thus increasing the cost of feeding.

In general, the replacement of maize with leaves or forages has been more successful in grower-finisher diets of broiler chickens than in the starter phase (Teguia *et al.,* 1993; 1996; 2002). The substitution rate in grower-finisher diets varied from 100 to 300 g/kg diet for *Desmodium spp*, sweet potato and *Vernonia spp* leaves, respectively. However, up to 60 g maize/ kg starter diet could be replaced by *Desmodium* leaves without a significant, detrimental effect on weight gain, feed consumption and feed conversion ratio (Teguia *et al.,* 2002). The major negative factor in these plants was the high fibre content associated with a lower metabolisable energy concentration. On the other hand, the diets containing the leaf meals had higher protein content. The high fibre level will have induced a poor digestibility of the diets associated with a higher feed consumption and poorer efficiency of feed utilisation. The use of young leaves could alleviate the negative effect of fibre and allow higher dietary inclusion levels. It would therefore be important to determine the optimum harvesting time for each of the leaves so as to obtain optimum nutritional characteristics. This also holds for the tannin content of bitter leaves (*Vernonia spp)* which is known to affect protein digestion in chickens (Rostango, 1972). It may be noted that in addition to its potential as feedstuff for broilers, *Desmodium* leaves meal may also influence carcass quality. The feeding of *Desmodium* leaves instead of maize induced a lower amount of abdominal fat, but the effect was not statistically significant (Teguia *et al.,* 2002).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Collection and Processing of Mango seed into Mango Seed Kernel Meal

Local variety of Mango Seed Kernel (kanbiri) and mixed samples of Mango Seed Kernel were collected from various locations in Kaduna State such as Zaria City, Sabon Gari, Soba and Giwa. They are readily available in the area of study.

The collection was done during the months of April and May which represents the peak of the mango season in Zaria, the kernel of the two different samples were obtained by cutting the seed coat using a knife or crushed with a stone. The Mango Seed Kernel (MSK) obtained was divided into two parts. One part was soaked while the other part was sundried.

3.1.1 Soaking of Mango Seed Kernel for 72 Hours

The Local variety of Mango Seed Kernel (Kanbiri) and the mixed kernels were soaked separately in water for 72 hours at the rate of 100g per litre of water in containers. There was change of water at regular intervals of 8 hours for 3 days. The Mango Seed Kernels were then removed and sundried. The dried MSK were then milled before incorporation into the diets.

3.1.2 Boiling of Mango Seeds Kernel

The local variety of Mango Seeds Kernel (Kanbiri) and mixed samples of Mango Seeds Kernel was put in boiling water separately at the rate of 100g per litre of water at 100^oC temperature for 30 minutes. The samples were removed, drained, sun dried, and milled before incorporation into the diets.

3.2. Determination of Anti-Nutritional Factors in Mango Seeds Kernel

The anti-nutrient compositions of raw and differently processed samples of mango seed kernel were determined by the methods indicated below.

3.2.2 Determination of the proximate composition of Mango Seed Kernel

The proximate composition (Table 1) was obtained by analyzing the different samples of mango seeds kernel according to the methods described by AOAC(1990).

Table3.1: Proximate composition of differently processed Mango-Seed Kernels (MSK)

	Treatments			
Parameters (%)	**T1**	**T2**	**T3**	**T4**
Dry mater	90.48	96.28	95.27	96.28
Crude Protein	7.23	7.49	7.38	6.50
Crude Fibre	4.93	4.90	3.08	3.39
Ether Extract	3.98	3.77	4.01	4.00
Ash	6.23	6.02	6.15	6.26
N.F.E	77.63	76.37	77.38	79.85

T1 = Mixed sample boiled

T2 = Mixed sample soaked

T3 = Kanbiri variety boiled

T4 = Kanbiri variety soaked

N.F.E= Nitrogen Free Extract.

Table3.2: Effects of Processing Methods on the Levels of Anti-nutritional Factors in Local variety (Kanbiri) and Mixed Sampel of mango seed kernel

Parameters	Treatments					
	Raw Kanbiri	**Raw Mixed Samples**	**Kanbiri Soaked**	**Kanbiri boiled**	**Mixed sample soaked**	**Mixed sample boiled**
Phytate (g/100g)	0.90	0.93	0.16	0.14	0.28	0.24
Reduction (%)	-	-	82.22	84.44	69.89	74.19
Tannins (mg/g)	0.14	0.34	0.08	0.04	0.24	0.18
Reduction (%)	-	-	42.86	37.43	29.41	47.06
Cyanide (ug/g)	0.18	0.25	0.04	0.04	0.04	0.06
Reduction (%)	-	-	77.78	77.78	84.00	76.00
Oxalate (mg/g)	0.05	0.71	0.40	0.38	0.64	0.68
Reduction (%)	-	-	20.00	24.00	9.86	4.23

Phytic acid was determined by the procedure described by Luhcas and Makakas (1975) and calculated using the formula % phytic acid = xx 1.19x100/2. Where x = Titre value x 0.00195. Tannic acid (Tannin) was determined as tannic acids as described by Mega (1982) and oxalate using the method of Fasset (1966).

3.3 EXPERIMENT 1:

Replacement value of local variety of mango seeds kernel (Kanbiri) and mixed samples of mango seeds kernel meal for maize in Broiler starter

3.3.1 Experimental Site

The experiment was carried out at the Poultry Unit farms, Department of Animal Science Ahmadu Bello University, Samaru, Zaria located on the latitude 11^0E and 12^0N of the equator and altitude of 640m above sea level. It has annual rainfall of 1100mm which starts from late April and early May to mid October. The maximum temperature varies from 26-32^0C depending on the season, while the mean relative humidity during dry and wet season are 21% and 72% respectively. (Meteorological unit, IAR)

3.3.2 Preparation of Experimental diets

Five broiler starter diets were formulated. Diet 1 was the control 0% MSKM, diet 2 and 3 contained soaked and boiled MSKM respectively of Kanbiri variety at 60.6% replacement value for maize (Table 3.3). Diets 4 and 5 also contained soaked and boiled MSKM of mixed samples at 60.6% replacement value of maize respectively (Table 3.3) The five experimental diets that constituted the treatments were formulated to be isocaloric and isonitrogenous (CP = 23%, ME = 2900kcal/kg) ensuring that they meet the requirements for calcium, phosphorus and lysine for broiler starter (NRC.1994) The chicks were fed the experimental diets for the starter period (0-4 weeks).

Table3.3: Composition of Broiler starter diets (0-4 weeks) Experiment 1

Ingredients	Treatment				
		Loacal V. (Kanbiri)		Mixed Samples	
	Control T1	Soaked T2	Boiled T3	Soaked T4	Boiled T5
Maize	40.00	15.00	15.00	15.00	15.00
Soya beans(full fat)	36.05	36.24	36.24	36.24	36.24
MSKM	0.00	25.00	25.00	25.00	25.00
GNC	10.00	10.00	10.00	10.00	10.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	0.50	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.2	0.2	0.2	0.2	0.2
Salt	0.30	0.30	0.30	0.30	0.30
*Vit Premix	0.25	0.25	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**	**100**	**100**
Calculated analysis					
ME (KcalsKg)	2,944	2,925	2,929	2,903	2,912
Crude Protein %	23.00	23.00	23.00	23.00	23.00
Crude fibre %	3.80	3.90	3.90	4.30	4.30
Ether Extract %	9.40	9.60	9.50	9.40	9.60
Calcium %	1.20	1.22	1.22	1.22	1.22
Phosphorus %	0.93	0.52	0.52	0.52	0.52
Lysine %	1.15	1.50	1.50	1.50	1.50
Methionine %	0.54	0.49	0.50	0.50	0.50

* Vitamin premix Composition of vitamin per kg is as follows: Vitamin A, 8000iu; Vitamin D31600iu; Vitamin E5iu; Vitamin K 0.200mg; Vitamins B, thaimine B. 0.5mg; Riboflavin B_2 4mg; Pyridoxine B_6 0.015mg; Niacin 0.015mg; B_{12} 0.01mg; Pantothenic acid 0.5mg; folic acid 0.5mg and Biofin 0.020mg; chlorine chloride 0.02mg; Anti-oxidant 0.125g and Minerals (Mn, Zn, Fe, Cu, I, Si Co) 0.056g.

MSKM= Mango Seed Kernel Meal

GNC= Groundnut Cake

ME=Metabolizable energy

3.3.3 Experimental Design and Management of Birds

A total of two hundred and twenty five (225) broiler birds obtained from Nu- BREED Farms, Ibadan Oyo State were used for the study. The birds were fed diets containing the test material mango seed kernel meal (MSKM) at day old. They were weighed and randomly divided on the basis of initial weight to five treatment groups of 45 chicks per group in a completely randomized design consisting of three replicates of 15 birds each. Birds were reared in a deep litter poultry house with feed and water provided *ad libitum*. Left over feed and body weight of birds were monitored on a weekly basis for the starter and finisher phases of the experiment and routine vaccines were given as recommended. All feed not consumed were removed, weighed and recorded at the end of each week to enable calculations of weekly intake of feed. Daily water intake was obtained as follows; fresh water of known volume was supply daily. Before each supply, previous day left over water was measured. Daily water consumption was thus obtained by subtracting left over water from the total volume of water supplied. Two control drinker were placed in the experimental house at different locations each day to account for evapourative losses. Feed conversion ratio and feed cost per kg gain were calculated

Finisher Phase:

3.3.4 Replacement value of Local variety of Mango Seeds kernel (Kanbiri) and mixed samples of Mango seeds kernel meal for maize in Broiler finisher

3.3.5 Experimental Diets

Five broiler finisher diets were formulated. Diets 1 was the control 0% MSKM, Diets 2 and 3 had boiled and soaked MSKM of Kanbiri variety at 60% replacement value of maize respectively, while Diets 4 and 5 had also soaked and boiled MSKM of mixed samples at 60% replacement value for maize respectively (Table 4) The diets were formulated to be isocaloric and isonitrogenous (CP = 20%, ME = 2950kcal/kg). The diets were also formulated to meet the requirements for energy, protein, calcium, phosphorus and lysine for broiler finisher (NRC.1994) The chicks were fed the experimental diets from 5-8 weeks.

Table3.4: Composition of Broiler Finisher diets (5-8 weeks) Experiment 1

Ingredients (%)	Treatments				
		Local V. (Kanbiri)		Mixed Samples	
	Control T1	Soaked T2	Boiled T3	Soaked T4	Boiled T5
Maize	50.00	19.40	19.40	19.40	19.40
Full fat soya bean	25.12	26.15	26.15	26.15	26.15
MSKM	0.00	30.00	30.00	30.00	30.00
GNC	10.00	10.00	10.00	10.00	10.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30
*Vit Premix	0.25	0.25	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**	**100**	**100**
Calculated analysis					
ME Kcals/Kg	2923	2918	2923	2892	2902
CrudeProtein %	20.00	20.00	20.00	20.00	20.00
Crude fibre %	4.10	4.20	4.00	4.60	4.70
Ether Extract %	8.10	7.90	7.90	7.90	7.90
Calcium %	1.2	1.4	1.4	1.4	1.4
Phosphorus %	0.96	0.89	0.89	0.89	0.89
Lysine %	1.0	0.93	0.93	0.93	0.93
Methionine %	0.54	0.50	0.50	0.50	0.50
FeedCost(N/kg)	58.65	58.65	58.61	58.65	58.61

* Vitamin premix! Composition of vitamin per kg is as follows: Vitamin A, 8000iu; Vitamin D31600iu; Vitamin E5iu; Vitamin K 0.200mg; Vitamins B, thaimine B. 0.5mg; Riboflavin B_2 4mg; Pyridoxine B_6 0.015mg; Niacin 0.015mg; B_{12} 0.01mg; Pantothenic acid 0.5mg; folic acid 0.5mg and Biofin 0.020mg; chlorine chloride 0.02mg; Anti-oxidant 0.125g and Minerals (Mn, Zn, Fe, Cu, I, Si Co) 0.056g.

MSKM= Mango Seed Kernel Meal

GNC= Groundnut Cake ME=Metabolizable energy

3.3.6 Experimental Design and Management of Birds

Two hundred and ten (210) birds were used for this study. At the end of the starter phase of experiment 1, all the birds in the various groups were pooled together and fed a common diet for one week, after which they were randomly allocated to 5 dietary groups and given finisher diets as in the starter phase. There were three replicates, each replicate per treatment group having 14 birds. The experiment was a completely randomized design. The birds were housed in pens under the deep litter system. Routine medications were administered as follows: Day old marek vaccine, day 2 new castle disease, day 9 1st dose of infectious bursa (Gumboro vaccine), day17 2nd new castle disease vaccine (lasota) day 24 gumboro vaccine.

3.3.6 Parameters Measured

Performance characteristics were monitored in terms of feed intake, weight gain, and feed to gain ratio. Water intake was measured and mortality recorded.

3.3.7 Carcass Analysis

Three birds were selected from each treatment based on the group mean weight for the carcass analysis. The selected birds were fasted overnight and thereafter bled by severing the jugular vein, followed by scalding in hot water and subsequently defeathered. The head, neck, shank and viscera were removed to get the dressed weight and percentage dressed weight calculated. The thigh, drumstick and back were removed from each carcass. All parts were weighed and expressed as percentages of the dressed weight.

Also, organs like the heart, kidney, spleen, lungs and gizzard were weighed and equally expressed as percentages of the dressed weight.

3.3.8 Haematological Evaluation

At the end of finisher phase of the experiment, 2 mls of blood was collected through the wing vein of each bird per replicate, into sterile universal bottles containing anti-coagulant ethylene diamne tetra acetic acid (EDTA). The samples were sent to the Clinical Pathology laboratory, Ahmadu Bello University Teaching Hospital, Shika, Zaria, for the analysis of packed cell volume (PCV) heamoglobin (Hb), total protein (TP), red blood cells (RBC), white blood cells (WBC), Neutrophils (N), Eusinophils (E) and Lymphocytes (L).

3.4 Experiment 2:

Effect of replacing maize with graded level of local variety (Kanbiri) of Soaked Mango Seeds kernel meal on the performance of broiler starter.

Source of experimental birds

All birds (broilers) used in the experiment were purchased from Nu-BREED farms Ibadan, Oyo State.

3.4.1 Preparation of Experimental Diets

Soaked mango seed kernel meal of local variety (Kanbiri) was used to replace maize in a starter broiler diets at graded levels of 0, 20, 40, 60, 80 and 100% designated as T1, T2, T3, T4, T5 and T6 respectively (Table 3.5). The diets were formulated to be isocaloric and isonitrogenous. (CP = 23%, ME = 2950 Kcal/kg) as well as meeting the requirements for calcium, phosphorus and lysine (NRC, 1994). The diets were fed for four weeks (0-4) weeks.

3.4.2 Experimental design and Management of birds

A total of two hundred and seventy (270) day old chicks were used in this study. The birds were fed diets containing the test materials from day old. They were weighed and randomly divided on the basis of initial weigh to six treatment groups of 45 chicks per group in a completely randomized design consisting of three replicates of 15 birds each. Birds were reared in a deep litter poultry house with feed and water provided *ad libitum* for 28 days.

Table3.5 Composition of Experimental Diets for Broiler Starter (%)

Ingredients/Diets	Treatments					
	0%	20%	40%	60 %	80%	100%
	T1	T2	T3	T4	T5	T6
Maize	53.00	41.04	29.35	18.33	7.29	0.00
Groundnut cake	25.00	26.36	27.45	27.87	28.31	25.00
MSKM	0.00	10.60	21.20	31.80	42.40	53.00
Soybean (full fat)	10.00	10.00	10.00	10.00	10.00	10.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Prex	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100

Calculated analysis

ME (kcal/kg)	2993	2994	2959	2954	2937	2948
Crude protein	23.00	23.00	23.00	23.00	23.00	23.00
Ether extract %	6.95	7.02	7.03	7.10	7.12	7.0
Crude fibre	3.92	3.93	3.98	4.09	4.17	4.0
Calcium %	1.27	1.27	1.27	1.18	1.18	1.18
Phosphorus %	0.92	0.92	0.91	0.90	0.90	0.89
Lysine	1.02	1.00	1.00	1.00	1.00	1.00
Methionine	0.67	0.65	0.63	0.63	0.64	0.65

* Vitamin premix! Composition of vitamin per kg is as follows: Vitamin A, 8000iu; Vitamin D31600iu; Vitamin E5iu; Vitamin K 0.200mg; Vitamins B, thaimine B. 0.5mg; Riboflavin B_2 4mg; Pyridoxine B_6 0.015mg; Niacin 0.015mg; B_{12} 0.01mg; Pantothenic acid 0.5mg; folic acid 0.5mg and Biofin 0.020mg; chlorine chloride 0.02mg; Anti-oxidant 0.125g and Minerals (Mn, Zn, Fe, Cu, I, Si Co) 0.056g.

MSKM= Mango Seed Kernel Meal

GNC= Groundnut Cake

ME=Metabolizable energy

Table3.6 Composition of Experimental Diets for Broiler (%)

	Inclusion of MSKM					
Ingredient/Diets	0%	20%	40%	60 %	80%	100%
	T1	T2	T3	T4	T5	T6
Maize	57.61	45.63	33.64	21.66	9.66	0.00
Groundnut cake	21.39	21.85	22.32	22.77	23.25	21.39
MSKM	0.00	11.52	23.04	34.57	46.09	57.61
Soybean (full fat)	10.00	10.00	10.00	10.00	10.00	10.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	4.00	4.00	4.00	4.00	4.00	4.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Prex	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100

Calculated analysis

ME (kcal/kg)	3013	2972	2976	2959	2954	2944
Crude protein %	21.00	21.00	21.00	21.00	21.00	21.00
Ether extract	6.5	6.5	6.5	6.7	6.9	6.5
Crude fibre	3.3	3.4	3.4	3.5	3.7	3.6
Calcium %	1.3	1.3	1.2	1.2	1.2	1.2
Phosphorus %	0.9	0.9	0.8	0.8	0.8	0.8
Lysine	1.12	1.1	1.1	1.1	1.1	1.1
Methionine	0.6	0.55	0.53	0.55	0.55	0.55

* Vitamin premix! Composition of vitamin per kg is as follows: Vitamin A, 8000iu; Vitamin D31600iu; Vitamin E5iu; Vitamin K 0.200mg; Vitamins B, thaimine B. 0.5mg; Riboflavin B_2 4mg; Pyridoxine B_6 0.015mg; Niacin 0.015mg; B_{12} 0.01mg; Pantothenic acid 0.5mg; folic acid 0.5mg and Biofin 0.020mg; chlorine chloride 0.02mg; Anti-oxidant 0.125g and Minerals (Mn, Zn, Fe, Cu, I, Si Co) 0.056g.

MSKM= Mango Seed Kernel Meal

GNC= Groundnut Cake

ME=Metabolizable energy

Body weight of birds were monitored on a weekly basis for the starter and finisher phases of the experiment and routine vaccines were given as recommended. All feed not consumed were removed, weighed and recorded at the end of each week to enable calculation of weekly intake of feed.

The average daily feed intakes daily weight gain, feed conversion ratio, and feed cost per kg gain were calculated by multiplying feed conversion ratio by feed cost.

3.4.3 Design and Management of Broiler Finisher

The design and management of broiler finisher was the same as in the starter phase.

Carcass Analysis

The carcass analysis for this experiment was the same as in experiment 1

Haematological Evaluation

The same as described in experiment 1

Statistical Analysis

Data obtained from all the experiments were subjected to analysis of variance, using the general linear model procedure of SAS (2001). Significant differences among treatment means were separated using the Duncan's multiple Range Test Duncan (1955).

CHAPTER FOUR

4.0 RESULTS

4.1 Effects of processing Methods on the Levels of Anti-nutritional Factors in Local variety (Kanbiri) and Mixed Samples of mango seed kernel:

The levels of reduction and percentage reduction of anti-nutritional factors (ANF) due to the various processing methods are presented in Table 3.2. The result show that the values obtained for raw Kanbiri variety of mango seed kernel was similar to the values of raw mixed samples of mango seed kernel for phytate, tennin and cyanide. Values obtained for oxalate was higher in the mixed sample than kanbiri variety (0.71% and 0.05% respectively). The value of 0.90g/100mg phytate content of raw kanbiri variety of mango seed kernel was reduced to 0.16 and 0.14 g/100g corresponding to 82.22 and 84.44 % when the kernel were soaked and boiled respectively. Also, soaking and boiling reduced 0.14 mg/g of tannin content of the kanbiri variety of mango seed kernel to 0.08 and 0.04 mg/g respectively this corresponded to 42.86 and 47.43 % reduction. The cyanide content (0.18µg/g) in this experiment was reduced to 0.04 and 0.04 µg/g respectively corresponding to 77.78 and 77.78 % respectively when Kanbiri variety of mango seed kernel was soaked and boiled. Also, soaking and boiling of the Kanbiri variety of mango seed kernel was able to reduce oxalate from 0.50 to 0.4 and 0.38 corresponding to 20.00 to 24.00% respectively.

When the mixed samples of mango seed kernel was processed by soaking and boiling, the value of 0.93g/100mg of phytate was reduced to 0.28 and 0.24 g/100g corresponding to 69.89 and 74.19 % respectively. Also, soaking and boiling reduced 0.34 mg/g of tannin content of mixed samples of mango seed kernel to 0.24 and 0.18 mg/g respectively this corresponded to 29.41 and 47.06 % reduction. The cyanide content (0.25µg/g) of mixed samples of mango seed kernel was reduced to 0.04 and 0.06 µg/g respectively corresponding to 84.00 and 76.00 % respectively when the kernel was soaked and boiled. Soaking and boiling of the mixed samples of mango seed kernel was able to reduce oxalate from 0.71 to 0.64 and 0.68 corresponding to 9.86 to 4.23% respectively.

Experiment1:

4.2 Performance of Broiler Starter Fed MSKM

The effect of local variety of MSKM (Kanbiri) and mixed samples of MSKM on the performance of broiler chicks is presented in Table 4.1 the final weight was significantly ($P<0.05$) higher for the control group compared to all other treatments. The average water intake was significant ($P<0.05$) higher in birds fed soaked mixed samples of MSKM based diet (T4) compared to T1 and T5 but similar to T2 and T3. There were no significant differences ($P>0.05$) in the feed intake, weight gain, feed to gain ratio, feed cost per kg gain and mortality rate across the treatments ($P>0.05$).

4.3 Performance of Broiler Finisher Fed MSKM

The effect of local variety of MSKM and mixed samples of MSKM on the performance of broiler finisher is presented in Table 4.2. The results indicated that the final body weight was significantly ($P<0.05$) higher in the control compared to birds that were fed with soaked mixed sample of MSKM based diets (T4) but similar to all other treatments. The feed to gain ratio, water intake, feed cost per kg gain were significantly better in the control group (T1) compared to T3, T4 and T5 but similar to the values in T2. The mortality rate was significantly ($P<0.05$) higher in T2 group compared to all MSKM based diets but was similar to T1. There were no significant differences in the feed intake and weight gain across the treatments ($P>0.05$).

Table 4.1 Performance of Broiler Starter Fed MSKM

	Treatments					
		Local V. (Kanbiri)		Mixed Samples		
Parameters	Control	Soaked	boiled	soaked	boiled	
	T1	T2	T3	T4	T5	SEM
Initial body weight (g)	40.00	40.00	40.00	40.00	40.00	0.00
Final body weight (g)	486.67^{a}	406.67^{b}	393.33^{b}	433.33^{ab}	383.33^{b}	14.92
Av. Feed intake (g/b/day)	30.33	31.33	27.67	33.67	26.67	0.02
Av. Weight gain (g/b/day)	17.00	16.00	15.33	15.00	14.33	0.04
Feed to gain ratio	2.04	1.97	1.97	2.29	2.08	0.32
Av. water intake (ml/day)	273.60^{b}	346.30^{ab}	346.27^{ab}	434.46^{a}	273.40^{b}	7.04
Feed cost/kg gain (₦)	132.06	120.20	118.84	140.16	125.49	8.02
Mortality (%)	1.67	1.67	1.00	2.33	1.67	0.04

ab = Means with different superscripts in the same row are significantly different (P < 0.05)

SEM = standard error of the means

Table 4.2 Performance of Broiler Finisher Fed MSKM

		Local V. (Kanbiri)		Mixed Samples		
	Control	Soaked	Boiled	Soaked	Boiled	
Parameters	T1	T2	T3	T4	T5	SEM
Initial body weight (g)	666.67	700.00	700.00	700.00	700.00	70.01
Final body weight (g)	1500.00 ^{a}	1080.00 ^{ab}	1036.70 ^{ab}	1000.00 ^{b}	1040.00 ^{ab}	158.31
Av. feed intake (g/b/day)	83.67	83.33	80.00	80.00	66.00	8.74
Av. weight gain (g/b/day)	45.00	30.00	25.33	25.33	24.00	12.86
Feed to gain ratio	1.87^{a}	2.50^{ab}	3.13^{b}	3.33^{b}	3.20^{b}	0.32
Water intake (ml/day)	10.20^{a}	10.63^{a}	9.37^{b}	9.33 ^{b}	9.47^{b}	0.23
Feed cost/kg gain (N)	119.96^{a}	146.61^{ab}	183.63^{b}	195.50^{b}	187.53^{b}	18.90
Mortality (%)	0.67^{ab}	1.33^{b}	0.00^{a}	0.33^{a}	0.00^{a}	0.26

ab = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

4.4 Carcass characteristics of Broiler Chicken Fed MSKM

Table 4.3 shows the carcass characteristics of broiler birds fed local (Kanbiri) and mixed sample of local mango seed kernel. The slaughter weight was significantly ($P<0.05$) higher in the control (16.0g) compared to the other treatments. The liver was significantly ($P<0.05$) higher in treatment 4 compared to treatment 3 while it was similar to T1, T2 and T4. The shank was significantly ($P<0.05$) lower in T4 compared to all other treatment. The spleen was similar in all the MSKM which was equally similar to the control. There were significant difference ($P<0.05$) in the dressing percentage and the percentages of the head, neck, wing, breast, back, heart, kidney, gizzard (full and empty), intestine (full and empty) abdominal fat, drum stick, thigh and length of the intestine across treatments.

4.5 Apparent Digestibility of Broiler Finisher Fed MSKM

Results of apparent digestibility of broiler finisher fed local variety (Kanbiri) and mixed samples of mango seed kernel meal is presented in Table 4.4. There was significant differences ($P<0.05$) in all the parameters monitored. Values of the dry matter were higher in T1, T2, T3 and T4 compared to T5. T1 also had a higher value for crude protein, crude fiber and ash compared to the rest of the treatments. However T5 recorded a higher value for ether extract and NFE compared to other treatments.

Table 4.3 Characteristics of Broiler Chicken Fed MSKM

	Treatments					
		Local V. (Kanbiri)		Mixed samples		
	Control	Soaked	Boiled	Soaked	Boiled	
Parameters (g)	T1	T2	T3	T4	T5	SEM
Live weight (g)	1833.33^{a}	1466.67^{b}	1366.67^{b}	1366.67^{b}	1366.67^{b}	55.84
Slaughter wt (g)	1600.00^{a}	1266.7^{b}	1300.00^{ab}	1320.00^{ab}	1266.70^{b}	76.10
Dressed wt (g)	1466.70^{a}	1200.00^{ab}	1200.00^{ab}	1220.00^{ab}	1166.70^{b}	80.35
Dressing %	56.54	52.08	56.23	60.07	55.88	4.35
Thigh%	10.56	11.59	11.23	11.56	11.79	0.87
Drum stick%	11.97	11.03	11.13	11.03	10.82	0.74
Breast%	16.63	15.20	16.03	15.37	16.27	1.48
Back%	15.71	13.88	15.53	15.73	14.23	1.02
Head %	3.52	3.76	3.53	3.13	2.28	0.21
Neck%	3.79	5.91	6.20	5.73	5.53	0.79
Wing%	9.993	9.44	9.26	8.82	9.41	0.53
Liver%	2.54^{ab}	2.10^{ab}	2.05^{b}	2.77^{a}	2.28^{ab}	0.21
Spleen%	0.14^{b}	0.17^{ab}	0.17^{ab}	0.16^{ab}	0.17^{ab}	0.01
Heart%	0.065	0.44	0.50	0.47	0.58	0.10
Kidney%	0.83	0.56	0.58	0.81	0.83	0.10
Gizzard full%	3.47	3.69	3.48	3.10	3.94	0.71
Gizzard empty%	2.37	3.01	2.33	2.32	2.34	0.21
Intestine length (cm)	225.33	248.00	250.67	238.67	239.67	11.77
Intestine full%	7.54	8.76	8.71	8.19	9.21	0.79
Intestine empty%	4.27	4.97	4.81	4.67	4.33	0.34
Abdominal fat%	1.72	1.65	1.31	2.88	1.19	0.65
Shank%	5.64^{a}	5.74^{a}	5.31^{a}	3.65^{b}	5.74^{a}	0.33

ab = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

Table4.4 Apparent Digestibility of Broiler Finisher Fed MSKM

	Treatments					
		Kanbiri		Mixed samples		
Parameters (%)	T1 Control	T2 Soaked	T3 Boiled	T4 Soaked	T5 Boiled	SEM
Dry matter	84.50^{a}	85.16^{a}	84.10^{a}	84.15^{a}	80.84^{b}	0.54
Crude protein	92.45^{a}	90.69^{b}	89.44^{b}	86.98^{c}	89.74^{b}	0.52
Crude fiber	56.36^{a}	44.38^{b}	40.91^{b}	41.58^{b}	45.52^{b}	1.73
Ether extract	75.77^{b}	91.08^{a}	90.53^{a}	88.75^{a}	87.29^{a}	1.24
Ash	47.26^{a}	46.61^{a}	42.77^{a}	44.39^{ab}	42.52^{b}	0.90
NFE	70.44^{ab}	62.03^{b}	63.71^{b}	59.97^{b}	79.37^{a}	3.29

abc = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

NFE= Nitrogen free extract

4.6 Haematological profile of Broiler Finisher Fed MSKM

The effects of local variety of MSK (Kanbiri) and mixed samples of MSKM base diets on the haematological profile of the broiler finisher are presented in Table 4.5. The Total protein was significantly ($P<0.05$) higher in T1 and T2 compared to the other treatments. There were no significant differences in the packed cell volume, haemoglobin, red blood cell count, white blood cell, neutrophil, eosinophil and lymphocyte across the treatments.

Experiment 2:

4.7 Performance of Broiler Starter Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

The effects of graded levels of local variety (Kanbiri soaked) of MSKM on the performance of the broiler starter is presented in Table 4.6. The result showed that the final body weight was significantly ($P<0.05$) higher in treatment T1 compared to other treatments. The weight gain was significantly ($P<0.05$) higher in T1 compared to others. The feed to gain ratio and feed cost per kg gain were significantly ($P<0.05$) poorer in T6 compared to other treatments. There was no significant difference in feed intake across the treatments.

4.8 Performance of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

The effects of graded levels of local variety (Kanbiri soaked) of MSKM on the performance of the broiler finisher is presented in Table 4.7. The final weight and weight gain were significantly ($P<0.05$) higher in T1 compared to T3, T4, T5 and T6 but similar to T2. The feed intake was significantly ($P<0.05$) higher in T2 compared to T5 but similar to the other treatments. The feed to gain ratio was significantly ($P<0.05$) better in T1 compared to other treatments. The feed cost per kg gain was significantly (P<0.05) lower in T1 and T2 compared to other treatments. There was no significant difference in the water intake across the treatments.

4.9 Carcass Characteristics of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

Table 4.8 shows the effects of replacing graded levels of local variety of soaked local variety (Kanbiri) mango seed kernel meal on the carcass characteristics of broiler finisher. Liveweight, slaughter weight and dressed weight were significantly (P<0.05) higher in T1(Control diets) and T2 compared to the other treatments. The weight of the head, heart, gizzard (full) and intestine were significantly (P<0.05) higher in T6 compared to T1. The weight of the drumstick, thigh, carcass and shank were significantly (P<0.05) higher in T2. There were no significant differences in the liver, neck, wings, breast, back, kidney, gizzard (empty) length of intestine, abdominal fat and spleen.

4.10 Apparent digestibility of Nutrients by Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

Table 4.8 shows the effects of graded levels of soaked local variety (Kanbiri) of mango seed kernel meal on the apparent digestibility of broiler finisher. The values for dry matter, crude protein and crude fiber were significantly higher in the control (T1) compare to others and were similar to T2. Values of ether extract were higher in T4, T5 and T6 compare to other treatments. The values of ash and NFE were significantly higher in T2 and T3 and were similar to those of T5 and T6 compared to other treatments.

Table4.5 Haematological profile of Broiler Finisher Fed MSKM

	Treatments					
		Local V. Kanbiri		Mixed Samples		
Parameters	**Control**	**Soaked**	**Boiled**	**Soaked**	**Boiled**	
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**
Packed cell volume (%)	32.67	31.00	32.67	29.33	31.67	1.38
Heamoglobin(g/dl)	8.73	10.00	9.89	9.77	8.87	0.48
Total protein g/l	4.00^{a}	4.00^{a}	2.27^{c}	3.13^{b}	3.20^{ab}	0.32
Red blood cells ($\times 10^{6}\mu l$)	2.33	2.37	2.37	2.27	2.37	0.08
White blood cells (($\times 10^{4}\mu l$)	5207.7	4762.0	4478.0	5124.0	4274.7	410.19
Neutrophil (%)	58.33	65.67	66.33	64.67	69.00	3.45
Eosinophil (%)	4.00	3.33	2.67	2.67	3.33	0.70
Lymphocyte (%)	37.67	31.00	31.00	32.67	27.67	3.49

ab = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means.

Table4.6 Performance of Broiler Starter Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

	Treatments						
Parameters	**T_1(0%)**	**T_2(20%)**	**T_3(40%)**	**T_4(60%)**	**T_5(80%)**	**T_6(100%)**	**SEM**
Initial body weight (g)	40.00	40.00	40.00	40.00	40.00	40.00	0.00
Final body weight (g)	366.7^{a}	300.00^{a}	200.00^{b}	233.33^{b}	200.00^{b}	166.67^{c}	23.57
Av. Weight gain (g/b/day)	1.67^{a}	1.29^{b}	0.81^{cd}	1.09^{bc}	0.86^{cd}	0.52^{d}	0.11
Av. Feed intake(g/b/day)	3.00	2.86	2.48	2.76	2.48	2.02	0.36
Feed to gain ratio	1.75^{a}	2.22^{a}	3.08^{ab}	2.63^{ab}	2.89^{ab}	3.96^{b}	0.43
Av. Water intake (ml/day)	27.30^{a}	26.30^{a}	23.79^{a}	24.57^{a}	25.03^{a}	19.50^{b}	1.45
Feed cost/kg gain (₦)	118.4^{c}	142.80^{bc}	178.15^{b}	143.39^{bc}	158.18^{bc}	243.81^{a}	16.55
Mortality	1.33^{a}	1.67^{a}	1.33^{a}	4.00^{ab}	1.00^{a}	6.00^{b}	0.91

abcd = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

Table4.7 Performance of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

	Treatments						
Parameters	**T1(0%)**	**T2 (20%)**	**T3 (40%)**	**T4(60%)**	**T5(80%%)**	**T6(100)**	**SEM**
Initial body weight (g)	420.00	420.00	420.00	410.00	410.00	410.00	0.00
Final body weight (g)	1500.00^{a}	1400.00^{a}	1133.33^{b}	1033.33^{b}	866.67^{c}	766.67^{c}	49.06
Av. Weight gain (g/b/day)	7.29^{a}	5.08^{ab}	3.71^{b}	3.10^{b}	3.05^{b}	2.91^{b}	0.73
Av. Feed intake(g/b/day)	14.16^{ab}	14.48^{a}	14.51^{a}	14.14^{ab}	13.48^{b}	13.91^{ab}	0.12
Feed to gain ratio	2.14^{a}	2.89^{b}	3.96^{c}	4.58^{d}	3.05^{b}	4.79^{d}	0.20
Av. Water intake (ml/day)	156.63	152.63	146.63	153.00	153.01	136.13	8.68
Feed cost/kg gain (₦)	177.06^{b}	172.19^{b}	237.18^{a}	264.52^{a}	236.04^{a}	237.68^{a}	11.10

abc = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

Table 4.8 Carcass Characteristic Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel

	Treatments						
Parameters (g)	**T1 (0%)**	**T2 (20%)**	**T3 (40%)**	**T4 (60%)**	**T5 (80%)**	**T6 (100%)**	**SEM**
Live weight (g)	1500.00[a]	1400.00 [a]	1133.33[b]	1033.33[b]	866.67[c]	766.67[c]	49.06
Slaughter wt (g)	1333.33 [a]	1300.00 [a]	1033.33[b]	900.00[bc]	566.67[cd]	700.00[d]	52.70
Dressed wt (g)	1233.33[a]	1200.00 [a]	966.67 [b]	800.00[bc]	666.67 [cd]	600.00[d]	57.73
Dressing %	58.01 [ab]	64.51[a]	53.03 [ab]	54.85 [ab]	50.83 [ab]	52.38 [ab]	3.69
Thigh (%)	11.12 [b]	12.86 [a]	10.99 [b]	9.80 [bc]	9.95 [bc]	9.15 [c]	0.14
Breast (%)	13.04	14.11	12.99	12.84	14.12	14.22	0.96
Back (%)	12.91	14.64	13.82	12.43	13.41	12.73	0.67
Head %	3.22 [c]	3.75 [b]	4.07 [ab]	3.67 [bc]	4.04 [ab]	4.36 [a]	0.15
Neck (%)	6.60	6.30	6.62	5.54	5.46	5.32	0.50
Wing (%)	8.48	8.83	8.70	8.57	9.74	9.46	0.49
Liver (%)	2.97	2.96	3.14	3.51	3.22	3.50	0.32
Spleen%	0.18	0.16	0.15	0.17	0.22	0.17	0.03
Heart%	0.56[b]	0.68 [ab]	0.60 [ab]	0.70 [ab]	0.61 [ab]	0.84 [a]	0.08
Kidney%	0.55	0.71	0.81	0.72	0.91	0.89	0.09
Lungs%	0.63 [b]	0.74 [ab]	0.53 [b]	0.65 [b]	1.12 [a]	0.92 [ab]	0.13
Gizzard full%	4.33 [b]	4.41 [ab]	5.23 [ab]	4.68 [ab]	5.05 [ab]	5.36 [a]	0.29
Gizzard empty%	2.62	2.68	3.15	2.78	3.01	2.99	0.25
Intestine length (cm)	250.67	230.00	238.67	233.00	243.33	243.33	12.89
Intestine jfull%	6.41 [d]	8.56 [cd]	11.24 [b]	10.58 [bc]	12.01 [ab]	13.09 [a]	0.71
Intestine empty%	3.45 [b]	3.81 [b]	6.16 [ab]	6.02 [ab]	6.82 [a]	6.85 [a]	0.83
Abdominal fat%	1.80	1.78	0.80	1.26	1.56	0.97	0.30
Shank%	5.21 [b]	6.36 [a]	5.76 [ab]	5.51 [ab]	5.51 [ab]	5.36 [ab]	0.32

abcd = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the mean

Table 4.9 Apparent Digestibility of Nutrients of Graded Levels of Local Variety of Soaked Mango Seed Kernel Meal Fed to Broiler Finisher

	Treatments						
Parameters (%)	**T_1(0%)**	**T_2(20%)**	**T_3(40%)**	**T_4(60%)**	**T_5(80%)**	**T_6(100)**	**SEM**
Dry matter	85.06^{a}	83.78^{b}	82.92^{bc}	82.09^{c}	80.79^{d}	80.54^{d}	0.31
Crude protein	91.59^{a}	87.08^{a}	75.22^{b}	70.16^{c}	61.35^{d}	57.52^{d}	1.56
Crude fiber	57.54^{a}	48.17^{b}	40.00^{c}	39.22^{cd}	35.68^{cd}	34.07^{d}	1.72
Ether extract	77.31^{d}	84.23^{c}	87.02^{b}	90.33^{a}	91.81^{a}	90.81^{a}	0.76
Ash	47.77^{b}	48.44^{a}	49.03^{a}	47.62^{ab}	45.67^{b}	45.66^{b}	0.76
NFE	73.42^{b}	77.95^{a}	73.24^{b}	73.53^{b}	75.40^{ab}	72.78^{b}	0.85

abc = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

NFE= Nitrogen free extract

4.11 Haematological Profile of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel.

Table 4.9 shows the haematological evaluation of replacing maize with graded levels of soaked local variety (Kanbiri) mango seed kernel. The total protein was significantly ($P<0.05$) higher in T1 compared to T3, T4 and T5 but similar to T2 and T6. There were no significant differences in the packed cells, neutrophil, eosinophil and lymphocyte counts across the treatments ($P>0.05$).

Table 4.10 Haematological Profile of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel

	Treatments						
Parameters	T_1(0%)	T_2(20%)	T_3(40%)	T_4(60%)	T_5(80%)	T_6(100%)	SEM
Packed cell volume (%)	41.33	44.33	44.67	44.00	43.00	42.33	2.18
Heamoglobin (g/dl)	13.17	14.03	14.76	14.77	15.13	14.30	0.61
Total protein g/l	2.80^{a}	2.67^{ab}	1.93^{c}	2.13^{bc}	2.13^{bc}	2.67^{ab}	0.19
Red blood cells (($\times 10^6$µl)	5.83	6.53	6.33	6.37	6.87	6.10	0.49
White blood cells (($\times 10^4$µl)	13.37	13.63	13.53	12.67	12.43	14.03	0.84
Neutrophil (%)	59.33	65.00	63.00	60.33	66.00	69.67	7.20
Eusinophil (%)	5.00	4.23	2.89	2.55	2.77	2.85	0.75
Lymphocyte (%)	37.33	33.00	36.67	36.33	34.00	30.33	8.08

abc = Means with different superscripts in the same row are significantly different ($P < 0.05$)

SEM = standard error of the means

CHAPTER 5

5.0 DISCUSSION

5.1 Effects of processing Methods on the Levels of Anti-nutritional Factors in Local variety (Kanbiri) and Mixed Samples of mango seed kernel

The values obtained for anti-nutritional factors parameters in this experiment for raw mixed samples of mango seed kernel were higher than those of raw kanbiri variety. The percentage of phytate 84.44% and 69.89 % for the soaked kanbiri variety and mixed samples of mango seed kernel respectively was higher than 41.60% reported by Dauda, (2006) for phytic acid after soaking pigeon pea for 24 hours at room temperature. The results of the cyanide content obtained for the soaked kanbiri variety and mixed samples of mango seed kernel was similar to the reports of Okolie and Ugochukwu, (1989). They observed that the soaking of some Nigeria legume seeds in water for 24 hours caused a drastic reduction in HCN. The study showed that soaking was effective as boiling in reducing the anti-nutritional factor in mango seed kernel. Oxalate was relatively resistance to prolong soaking.

Boiling of mango seed kernel was found to drastically reduce the anti-nutritional factors present in the seed. The percentage of phytate 84.44% and 74.19 % for the boiled kanbiri variety and mixed samples of mango seed kernel respectievely was higher than 41.27% reported by Adegbulu, (2004) for phytic acid after boiling African locust bean seed and similar to 79.29% recorded by Bawa *et al*., (2003) for lablab seeds. The results of the cyanide percentage (77.78% and 76.00%) reduction obtained for the boiled kanbiri variety and mixed samples of mango seed kernel respectively was similar to 70.25% reported by Bawa *et al*., (2003) after 25 minute of cooking lablab. The reduction in tannin level obtained with boiling mango seed kernel in this study, agrees with the report of Kaankuka *et al*., (1996) who observed that cooking was effective in reducing tannin content of soybean seeds. However, the percentage (47.43% and 47.06%) for both boiled kanbiri variety and mixed samples were lower than 77.06% reported by Chau-chifai *et al*. (1997) after cooking *Phaseoulus angularis* and *D. lablab* for 60 minutes.

5.2 Performance of Broiler Chicks and Finisher Fed MSKM

The increased weight gain as well as final body weight during the starters phase of broilers fed soaked local (Kanbiri) and mixed sample of mango seed kernel meal respectively could be due to the fact that during boiling, some of the nutrients might have been denatured as reported by Parsons *et al*. (1992) and the leaching of soluble proteins in processing water. Mbajunwa (1995) also reported the leaching of soluble minerals in water. This could be the reason for the reduced weight gain and final weight of birds that were fed boiled mango seed kernel. The values of the mortality recorded in this experiment could not be attributed to the test diet as a higher percentage of mortality was experienced in the control group. Values in the finisher phase, followed the trend in the starter phase.

5.3 Carcass Characteristic of Broiler Chicken Fed MSKM

The values of dressing percentage of 52.08-60.07% were similar to 60.82-65.22% earlier reported by Joseph and Abolaji (1997) who fed similar diets to broiler bird. Weight of the gizzard was affected by the amount of the feed particle in the gizzard (Abdelsamie *et al.,* 1983). The spleen, kidney and liver were also not affected by dietary treatment. Bawa *et al*. (2003) reported that the effects of feeding processed legume grain on organ yield were observed to be the best means of testing processing methods. The result was an indication that soaked and boiled mango seed had no effects on carcass characteristics of the birds and the nutrients were well utilized.

5.4 Apparent Digestibility of Broiler Finisher Fed MSKM

The values of the apparent digestibility were an indication of better utilization of the nutrients. However, there was a decline in the utilization of crude fiber by birds that were fed both soaked and boiled mango seed kernel ash digestibility was also low in birds that were fed boiled kanbiri variety and mixed samples of mango seed kernel respectively. The poor apparent digestibility and poor performance of birds fed diets containing mango seed kernel agrees with the report of Dafwang, (2001jk) that most farm waste used as non- conventional feed resources are poor in readily digestible feed nutrients. Mbajunwa (1995) also reported the leaching of soluble minerals in water when mango seed kernel was boiled hence reducing the available mineral to the birds.

5.5 Haematological profile of Broiler Finisher Fed MSKM

The values of haematological evaluation apart from the lymphocyte count in this experiment were within normal range for healthy birds as was reported by Sturkies, (1965), and similar to the values reported by Abeke *et al.* (2008) on broiler birds fed cooked *Lab lab purpureus* bean. The lymphocyte values were lower than the normal range for healthy birds as was reported by Sturkies (1965). It could be that the residual tannin depressed the immune system of the birds which reflected on the lymphocyte value. The values of neutrophil and eosinophil were within the normal range for healthy birds as was reported by Sturkies (1965). Abnormal values may be an indication of ill health, the values in this experiment was an indication that mango seeds kernel had no health implication on the birds.

5.6 Performance of Broiler Chicken Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel

The reasons for the decrease in feed intake in both the starter and finisher phase as the levels of soaked mango seed in the diet increased could be because of the astringent taste of mango kernel in this diets. This was also reflected in their weight gain. Also, it is possible that the concentration of the residual tannin after soaking increased as the levels of the soaked mango seed in the diet increases. This might have interfered with the intake of the diet and growth of the birds. Teguia, (1995) reported that ground mango kernels could be used to replace up to 200 g of maize per kg of broiler starter diet, but with some adverse effect on weight gain and feed consumption He further stated that Increasing the amount of mango kernels in the diet induced a linear depression of feed consumption. This result agreed with Diarra *et al* (2008) who fed raw and boiled mango seed kernel to broilers. The lower feed intake and the similarity in weight gain amongst treatments were the reason for the increased better feed conversion ratio in treatment 1 and 2.

5.7 Carcass Characteristics of Broiler Chicken Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel

The high values of carcass characteristics recorded in treatment 2 (20%) could be ascribed to better utilization by birds on this diets compared to those on other diets. Fetuga *et al*., (1975) suggested that carcass quality is closely related to level of nutrient especially protein and energy. Bawa *et al*. (2003) reported that trends in the slaughter weight are a reflection of growth performance. Growth performance decrease linearly with increased levels of mango soaked Kanbiri variety of mango seed kernel; this could be attributed to presence of residual tannin in the treated seed. The values of dressing percentage of 50.83-64.51% were similar to

60.82-65.22% earlier reported by Joseph and Abolaji (1997) who fed similar diets to broiler bird. This is an indication that soaked kanbiri mango seed had no negative effects on carcass characteristics and the nutrients were well utilized.

5.8 Apparent Digestibility of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel

The values of the apparent digestibility were an indication of better utilization of the nutrients. However they was a decline in the utilization of crude protein and crude fiber as the levels of mango seed kernel in the diet increased this could be attributed to the presence of residual tannins which may have been pronounced as the levels of mango seed kernel in the diet increased. Jansman *et al*., (1995) reported that tannins may also combine with proteins, including enzymes in the digestive tract and thereby negatively affect the digestibility of proteins and carbohydrates, thus reducing the chick's growth rate, the efficiency of feed utilisation and the availability of metabolisable energy of the diet (Rostango, 1972). This result also confirms the report of Dafwang, (2001) that most farm waste used as non-conventional feed resources are poor in readily digestible feed nutrients.

5.9 Haematological Profile of Broiler Finisher Fed Graded Levels of Local Variety of Soaked Mango Seed Kernel

The values of PCV in this experiment 41.33-44.67% were higher than the normal range (28-37%) for healthy birds reported by Sturkies (1965). Values of haemoglobin, red blood cells and white blood were similar to the normal range for healthy birds as was reported by Sturkies, (1965), and similar to the values reported by Abeke *et al.,* (2008) on broiler birds fed cooked *Lab lab purpureus* bean. The lymphocyte values in this experiment were lower than the normal range for healthy birds while values of neutrophil and eusinophil were within the normal range for healthy birds as was also reported by Sturkies (1965). The values of the lymphocyte could be attributed to the residual tannin left in the seeds which may have depressed the immune system of the birds, which now reflected on the lymphocyte values.

CHAPTER 6

6.0 SUMMARY, CONCLUSION AND RECOMENDSTIONS

6.1 Summary

Two experiments were conducted with two sets of birds. The first experiment was conducted to evaluate the replacement value of local variety (kanbiri) of mango seed kernel and mixed samples of mango seeds kernel meal as replacement for maize in broilers diets. The second experiment was conducted to evaluate the effect of replacing maize with graded level of local variety (Kanbiri) of soaked kernel meal on the performance of broilers.

At the end of the experiment, it was observed that local variety (Kanbiri) of soaked mango seed kernel was better than local variety (Kanbiri) of boiled mango seed kernel, and the mixed samples of local variety of mango seed kernel meal of both soaked and boiled in experiment one. It was also observed in the second expriment that local variety (kanbiri) of soaked mango seed kernel can replace maize up to 60%, but 20% replacement level gave the best result.

6.2 Conclusions

From the result of the feeding trials conducted, the following was concluded on the use of mango seed kernel in broilers diet.

i. Local variety (Kanbiri) of soaked mango seed kernel and soaked mixed samples of local variety of mango seed kernel can be used in broiler diet without adverse effects on the birds, although local variety (Kanbiri) of soaked mango seed kernel gave the best result.

ii. Water intake was significantly higher in birds that were fed diets containing local (Kanbiri) variety of soaked mango seed kernel compared to the control group.

iii. Mango seed kernel based diets does not affect the carcass characteristics of broiler chickens.

iv. Local variety (Kanbiri) of soaked mango seed kernel can be included up to 20% in the diets of broiler chickens without adverse effect on broiler performance.

v. The use of mango seed kernel can result in the reduction in the quantity of maize needed for broiler feeding.

vi. Mango seed kernel appear to be readily digestible when use in broiler ration.

6.3 Recommendations

The following recommendation was made for further research to enhance the utilization of mango seed kernel meal in broiler diets.

i. Other processing methods other than soaking and boiling that will help detoxify and improve the nutritive value of mango seed kernel should be investigated.The effect of enzyme supplementation on mango seed kernel based diet in broiler nutrition should be investigated for probable enhanced nutrient utilization.

ii. Proper assembling and storage of mango seed kernel which will make it more readily available should be encouraged, because this will help reduce the cost/kg of feeds and cost/kg gain of meat.

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