EFFECT OF JACKFRUIT BY PRODUCTS WITH PROBIOTICS ON THE GROWTH PERFORMANCE, SERUM LIPID PROFILE AND MEAT QUALITY IN BROILER

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Roll No: 0119/05

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June 2022

Authorization

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This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made

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List of abbreviations

Abbreviation	Elaboration
AGP=	Antibiotic growth promoter
ANOVA=	Analysis of variance
CF=	Crude fibre
CFU=	Colony forming unit
CP=	Crude protein
DM=	Dry matter
DOC=	Day old chick
EE=	Ether extract
FCR=	Feed conversion ratio
Ft=	Feet
g/b/d=	Gram per bird per day
GLM=	General linear model
HDL=	High density lipoprotein
IU=	International unit
Kcal/kg=	Kilocalorie per kilogram
LDL=	Low density lipoprotein
LW=	Live weight
MDA=	Malondialdehyde
ME =	Metabolizable energy
Mg=	Milligram
NGP=	Natural growth promoter
PFA=	Phytogenic feed additives
SEM=	Standard error of mean
TA=	Total Ash
TBARS=	Thiobarbituric acid reactive substance
TC=	Total cholesterol
TG=	Triglyceride
>=	Greater than
e.g=	Example
et al=	And his associates
%=	Percentage

i.e. =	That is
Sig. =	Significance
Ref. =	Reference

Abstract

The effect of jackfruit (*Artocarpus heterophyllus*) by products on performance of unsexed cobb-500 broiler chickens was investigated. The birds were divided into four dietary treatments having 3 replicates and 8 birds per replicate in a completely randomized design: Control (Basal diet), T1 (Basal diet + 0.8% dry jackfruit by products on DM basis), T2 (Basal diet + 1.2% on dry jackfruit by products on basis), T3 (Basal diet + 0.8% fermented jackfruit by products on DM basis) and T4 (Basal diet + 1.2% fermented jackfruit by products on DM basis). The results revealed that overall average daily gain (ADG) differed significantly ($P<0.05$) in all treatment groups compared to control. The average daily feed intake (ADFI) remained unchanged ($P<0.05$) among all the dietary groups. Feed conversion ratio of birds in treated group were the same and significantly better ($P<0.05$) than the control group. All visceral and total lymphatic organs weight remained unchanged in all treatment groups in comparison to control. Dressed weight significantly increased ($P<0.05$) in treatment groups particularly in T3. A significant rise in blood HDL levels and a fall in serum LDL and triglyceride levels which is compared to the control group. Thiobarbituric acid reactive substances (TBARS) considerably ($P<0.05$) lower in all additive treatment groups than in the control. The net profit from supplemented group differed significantly ($P<0.001$) than the control. Finally, dry and fermented *Artocarpus heterophyllus* by products increased ADG, serum HDL level, net profit and decreased FCR, serum LDL, triglyceride level and TBARS of meat. Hence, jackfruit by products showed beneficial effects on broiler and can be a potential source to be used as feed additives in broiler.

Key words: Broiler, jackfruit by products, growth performance, carcass characteristics, cost-benefit analysis.

Chapter-1: Introduction

1. Introduction

The demand for high-protein diets made from animal sources like meat and egg products is estimated to rise from 70% to 100% as a result of this anticipated expansion. Inadequate nutritive feed is a major factor that affects the production of livestock in the developing countries (Eyohet al., 2019). The poultry industry is viewed as a significant source to meet global demand among all other types of livestock husbandry (Godfray et al., 2010). In broiler farming, greater body weight genotypes, rigorous rearing methods, and high stock densities typically expose the birds to several stresses and various diseases (by pathogenic bacteria, viruses, fungi, and parasites). Inadequate immunization, indiscriminate drug use, unfavorable environmental conditions, and climatic fluctuations all raise the likelihood of broilers developing weakened immune systems, experiencing growth disruptions, and producing less. There are numerous approved proprietary immunomodulatory medications on the market right now. However, they have a low cost to benefit ratio, are poisonous, can interact with drugs, and may leave residues in tissues. So, the quest for an alternative for the prevention, treatment, and management of infectious diseases in broilers returned to our conventional medicine. With little information on their use in animals, many medicinal herbs have been shown to have growth-promoting and immunomodulatory effects. Broilers have not yet been subjected to studies on the immunomodulatory, antioxidant, and antibacterial characteristics of Artocarpus heterophyllus Lam. (Jackfruit tree).

It is native of Western India, Malaysia, East Africa, Southeast Asia, Caribbean, Florida, Australia, Puerto Rico, and Pacific islands (Siqueira, 2006). The fruits are big, sweet flavored, and have a strong and characteristic scent (Prakash et al., 2009). They are widely used as food and as traditional medicine ingested in nature or as sweets and homemade jelly.

All parts of jackfruit tree are used as traditional medicine. They recommended for the treatment of inflammation, malarial fever, kidney stones (Araújo and Lima, 2010), ulcers, infected wounds, diarrhea, fever, asthma, anemia, and dermatitis (Jagtap and Bapat, 2010) as well as soothing (Madaleno, 2011).

Scientific evidence of the healing properties of different parts of the jackfruit tree has already been presented. Particular emphasis has been given in the literature to the antioxidant activity from leaf, bark, peels and fruit extracts (Loizzo et al., 2010; Omar et al., 2011), Jacalin and artocarpin antiviral activity (Tamma et al., 2006), anticancer activity of artocarpin (Sun et al., 2017), anti-inflammatory activity of flavonoids isolated from the bark (Wei et al., 2005), and antibacterial (Khan et al., 2003a; Loizzo et al., 2010) and antifungal potential (Trindade et al., 2006) of several extracts and fractions.

So, this study was conducted to investigate the effects of jackfruit by products probiotics on growth performance, serum biochemical parameters and meat quality in broiler.

1.1 Objectives of the Study

- To observe the effect of jackfruit by products on growth performance and meat composition in broiler.
- To analyze the effects of dry and probiotic fermented jackfruit by products on serum biochemical parameter, oxidative stability of broiler.
- To check the oxidative stability of meat in broiler.
- To calculate the economics of using jackfruit by products as alternatives feed additives in broiler.

1.2 Research Hypothesis

Supplementation of jackfruit by-products with probiotics may improve the growth performance, serum parameters, oxidative stability and meat quality in broiler.

Chapter-2: Review of Literature

2.1 Jackfruit

The Artocarpus species have been used as traditional medicines. The plants have been used as anti-bacterial, anti-diabetic, antioxidant, anti-inflammatory and anti-helminthic. Jackfruit is which plays a vital role in lowering the blood pressure and maintaining bone health since it aids in calcium absorption and hence helps to strengthen the bones (Riyadh et al., 2020). Furthermore, the seeds are rich in highly soluble protein resulting in the prevention and treatment of mental stress and anxiety. The Jackfruit have low water and fat-absorption capacities, which helps in prevention of obesity. Every part of the plant has been used for both nutritional and medicinal purpose and so they are of economic value (Nwofia et al., 2012).

2.2 Chemical Composition and Nutritional Value

The chemical composition of jackfruit peels varies depending on the variety.

Table 1. Composition of jackfruit peels (g /100g edible portion).

Composition	Nutritional value of jackfruit peels
Water (g)	76.2 - 85.2
Protein (g)	2.0 - 2.6
Fat (g)	0.1 - 0.6
Carbohydrate (g)	9.4 - 12.5
Fibre (g)	2.6 - 3.6
Total sugars (g)	-
Total minerals (g)	0.9
Calcium (mg)	30.0 - 73.2
Magnesium (mg)	-
Phosphorus (mg)	20.0 - 57.2
Potassium (mg)	287-323
Sodium (mg)	3.0-35.0
Iron (mg)	0.4-2.9
Vitamin A (IU)	30
Thiamine (mg)	0.05-0.15
Riboflavin (mg)	0.05-0.2

Vitamin C (mg)	12.0-14.0
Energy (J)	50-210

Sources: Soumya et al. (2015).

2.3 Jackfruit peels is used medicinal purpose:

The jackfruit tree's numerous parts, including its peels, seeds, leaves, roots, stems, bark, and fruit, all contain a variety of physiologically active substances. As a result, jackfruit extracts can have a wide range of pharmacological effects. Various ailments have been treated with them using traditional medicine. Since tannin and saponin are found to have antmethanogenic activity, jackfruit by products can reduce methanogenesis in rumen liquor (Gangway et al., 2018).

2.3.1 Antioxidants

Jackfruit contains useful antioxidants (Ahmad, 2006), which prevent many human diseases. Antioxidants are substances that neutralize free radicals or their actions**.** Nature has endowed each cell with adequate protective mechanisms against the harmful effects of free radicals: superoxide dismutase (SOD), glutathione peroxidase, glutathione reductase, thioredoxin, thiols, and disulfide bonding are buffering systems in every cell. Antioxidants regarded as compounds are able to delay, retard, or prevent the oxidation process. The natural antioxidants in fruits and vegetables have gained increasing interest among food scientists, nutrition specialists, and consumers, as they are claimed to reduce the risk of chronic diseases and promote human health (AOAC international, 1990).

Vitamin C (ascorbic acid) is a water-soluble free radical scavenger. The daily recommended dietary allowance is 60 mg

2.3.2 Improving skin health

Damage to the skin occurs as a consequence of the natural aging process and damage is exacerbated in chronically sun-exposed skin (photoaging). Prolonged exposure to ultraviolet (UV) radiation has been identified as a cause of serious adverse effects to human skin, including oxidative stress, premature skin aging, sunburn, immune suppression, and skin cancer (Castanon, 2007).

As stated before, benefit of eating jackfruit that it is a good source of vitamin C. The human body does not make vitamin C naturally so we must eat food that contains vitamin C to reap its health benefits.

Jackfruit peels is gluten-free and casein-free, thus offer systemic anti-inflammatory benefits to skin. Jackfruit also contains antioxidants and has vitamin C, flavonoids, potassium, magnesium and fiber. Vitamin C is vital to the production of collagen, a protein that provides skin with structure and gives it its firmness and strength (Ravindran et al., 1996).

2.3.3 Improving stomach ulcer

Stomach ulcer is one type of peptic ulcer. A stomach ulcer is sometimes called a gastric ulcer. A stomach ulcer is usually caused by an infection with a bacterium called Helicobacter pylori. A 4 to 8 wk course of acid-suppressing medication will allow the ulcer to heal. In addition, a 1-wk course of 2 antibiotics plus an acid-suppressing drug will usually clear the Helicobacter pylori infection. This usually prevents the ulcer recurring again (Ferket et al., 2006). Gastric ulcer can result from persistent erosions and damage of the stomach wall that might even become perforated and develop into peritonitis and massive hemorrhage as a result of inhibition in the synthesis of mucus, bicarbonate, and prostaglandins. Various factors can contribute to the formation of gastric ulcer, especially the infection of stomach by Helicobacter pylori also frequent use of nonsteroidal anti-inflammatory drugs (NSAIDs) and consumption of alcohol (Douglas et al.,1992). The success of commercially available antiulcer drugs in the treatment of gastric ulcer is usually overshadowed by various side effects. For examples, H_2- receptor antagonists (such as cimetidine) may cause gynecomastia in men and galactorrhea in women while proton pump inhibitors (such as omeprazole and lansoprazole) can cause nausea, abdominal pain, constipation and diarrhea (Douglas et al., 1992). Due to those side effects, there is a need to find new antiulcerogenic compounds with potentially less or no side effects and medicinal plants have always been the main sources of new drug candidates for the treatment of gastric ulcer (Saxena et al., 2001). One of the plants that have been traditionally used in Indian and Malay folklore medicine to treat gastric ulcer is A. heterophyllus.

2.4 Probiotics

Probiotics are live, mono or mixed cultures of microorganisms that are given to a host through the digestive tract and have a positive impact on their health (Kabir, 2009a). Probiotics change metabolism by increasing digestive enzyme activity while decreasing bacterial enzyme activity and ammonia production, maintaining normal intestinal microbiota through competitive exclusion and antagonistic interactions, and enhancing feed intake and digestion (Apata, 2008; Kabir, 2009b). In addition to raising bacteriocins, lysozyme, and peroxides and stimulating the immune system, probiotics in chickens also lower stomach pH (Panda et al., 2006). The majority of the microorganisms utilized in animal feed are bacterial strains from various genera, with the *Lactobacilli*, *Bacilli*, *Streptococci* and *Sacharomcyces* kinds being the most prevelent.

2.4.1 Probiotics' effects on broiler nutrition

Probiotic species from the genus *Lactobacillus, Streptococcus*, *Bacillus*, *Bifidobacterium*, *Enterococcus*, *Aspergillus, Candida*, and *Saccharomyces* have been shown to improve broiler performance when included in broiler nutrition. In numerous investigations, the inclusion of probiotics to the diet was found to enhance broiler growth performance, feed conversion, and mortality reduction (Jin et al., 1997; Yeo and Kim, 1997; Kum Precht, 1998).

2.4.2 Evaluating probiotic effects on growth performance, meat quality in broiler:

Probiotic supplementation may have good consequences, according to studies on how it affects poultry performance. According to a study by Kabir et al. (2004*),* experimental birds live weight gains were considerably (P>0.01) higher than control birds. Numerous studies confirmed that findings showing that birds fed probiotics such Lactobacillus enhanced their live weight gain (Jin et al., 1997; Kamruzzaman et al., 2005; Mountzouris et al., 2007*).* Probiotics inactivated by a high-pressure homogenizer have been shown by (Huang et al., 2004) to improve the performance of broiler chickens in terms of output when employed at specific concentrations. However, Saccharomyces cerevisiae as a dietary probiotic had not demonstrated a difference in overall weight growth. Probiotic supplementation in broiler diet increased the meat quality both at refreezing and postfreezing storage, according to

(Kabir et al., 2004) who were studying the impact of probiotics on the sensory qualities and microbiological quality of dressed broiler meat. According to (Mahajan et al., 1999), the probiotic (Lactobacillus-Saccharomyces) fed group's meat had a lower total viable count compared to the meat from control birds and scored significantly (P>0.001) higher on the sensory attributes of appearance, texture, juiciness, and overall acceptability of the meat balls. The whole yeast or Saccharomyces cerevisiae extract can increase the tenderness of meat, according to research on the impact of Saccharomyces cerevisiae cell components on meat quality.

Broilers immunological responses to probiotics were observed to result in considerably increased antibody production (P>0.01) in experimental birds compared to control birds. Additionally, they showed that the variances in spleen and bursa weight between probiotic-fed and conventionally fed broilers might be linked to varying degrees of antibody generation in response to sheep red blood cells. Probiotics have been shown by Haghighi et al. (2005) to improve hens' serum and intestine natural antibodies to a variety of foreign antigens.

However, investigated the impact of feeding a probiotic based on *Lactobacillus* on the intestinal immune responses of broiler chickens during an Eimeria acervulina infection.

2.5 Summary

In this research both of this two beneficial natural growth promoters are combined together to observe its effect on growth performance carcass characteristics, serum parameters and meat quality in broiler and also a comparison with the dry jackfruit and control using different concentration is conducted to observe which preparation and concentration give better result.

Chapter -3 : Materials and Methods

3.1 Study area

The study was conducted at Chattogram Veterinary and Animal Sciences University (CVASU), Khushi, Chattogram, Bangladesh. The experiment was used for poultry trial and different analysis was conducted in Post Graduate and Nutrition laboratory of CVASU.

3.2 Study period and climatic condition

The research was conducted from August 2020 to January 2021.

3.3 Sample Collection

By-products of jackfruit were harvested from several locations in the Chattogram region. These were housed in a stainless-steel jar at the Animal Science and Nutrition Department.

3.4 Drying and Grinding of jackfruit by-products

Following collection, these were dried in a well-ventilated environment at a temperature of 27-28°C and humidity maintain 40-45c. To guarantee efficient combination with other feed ingredients, the peels were dried and processed into a fine powder using an electronic grinder. After that, the ground peels meal was stored in an airtight container until it was needed. The powdered peels were tiny enough to simply and uniformly mix with the substrate feed.

3.5 Microbial Cultures

MRS broth used for growth of *Lactobacillus plantarum a*nd YM broth for *Saccharomyces cerevisiae* as per instructions of the manufacturer. Two steps fermentation process was applied to prepare the jackfruit peels leaves probiotics using a laboratory incubator (LGI-150T, Lebnis, USA). In the initial inoculation, 1 percent *Lactobacillus plantarum* was added to solid culture media, which had a moisture level of roughly 40%, allowing the fermentation process to proceed effectively.

The combination was then fermented at 40°C for two days, with 5 hours of anaerobic and 3 hours of aerobic conditions alternated. The second fermentation was carried out with the addition of 1.0 percent

strains and fermented for 2 days at 40°C under aerobic conditions. Using a dry oven, the prepared probiotics mixes were dried for two days until the moisture content was less than 15% (Labnic, USA). 1 g of fermented peel meal was serially diluted with sterilized saline solution (0.85 percent NaCl) at room temperature and cultured in solid media to determine the number of cells.

After incubation at 37°C for 24–48 hours, the number of colonies on the culture plate was counted and expressed as cfu/ml.

3.6 Birds in Experiment

Cobb 500 was the bird strain used in the study. A total of 120 unsexed cobb 500 day old chicks were brought from Aga Agro Limited in Chattogram, Bangladesh. The chicks were all examined for malformations and to ensure that they were all the same size. The chick's average body weight was maintained (about 43 ±0.14g).

3.7 The Study Design

The layout of the experiment is presented in Table 2. For the experiment, a total of 120 birds was collected and randomly distributed in completely randomized design with following treatments:C as control (basal diet), T1 (basal diet with 0.8% dry jackfruit by products on DM basis), T2 (basal diet with 1.2% dry jackfruit by products on DM basis), T3 (basal diet with 0.8% probiotic fermented jackfruit by products on DM basis), T4 (basal diet with 1.2% probiotic fermented jackfruit by products on DM basis). Each treatment consisted of 3 replications having 8 birds.

Table 2. Design of experiment.

Dietary treatment groups	Replications	No. of Birds per replication	No. of Birds per treatment
Control (Basal diet)	R1	8	24
	R2	8	
	R3	8	

T1 = Basal diet with 0.8% dry jackfruit by products on DM basis	R1	8	24
	R2	8	
	R3	8	
T2 = Basal diet with 1.2% dry jackfruit by products on DM basis	R1	8	24
	R2	8	
	R3	8	
T3 = Basal diet with 0.8% probiotic fermented jackfruit by products on DM basis	R1	8	24
	R2	8	
	R3	8	
T4 = Basal diet with 1.2% probiotic fermented jackfruit by products on DM basis	R1	8	24
	R2	8	
	R3	8	
	Total		120

Table 3: Ingredients and chemical composition of experimental basal diets

Ingredients	Starter (0-14 days)	Grower to finisher (15-35 days)
Corn	52.00	53.00
Wheat	2.00	3.00
Rice polish	3.50	4
Soybean meal	31.00	29.20
Fishmeal	4.00	3.50
Palm oil	3.50	4.00
DCP	1.60	1.70
Limetsone	1.30	1.30
NaCl	0.30	0.30
Choline clholide	0.06	0.06
Vitamin min premix	0.15	0.15
L-lysine	0.40	0.40
DL-methionine	0.22	0.22
Toxin binder	0.10	0.10
Antioxidant	0.01	0.01
Enzymes	0.01	0.01
Total	100.00	100.00
Estimated value		
ME(kcal/kg)	3005.13	3108.34

CP(%)	22.16	20.77
Ca%	1.26	1.24
P%	0.69	0.68
CF%	3.76	3.68
EE %	3.67	3.68

3.8 Housing

The experimental shed is made of bricks and has a folding metal gate on one side for ventilation. Bird cages were chosen at random to maintain a uniform distribution of treatments and replications. Each treatment's replicate cages were placed in different parts of the house at random. The birds were housed in wire-floored, closed cages that were measured (3.5 ft. 1.63 ft. for 8 birds). As a result, each bird in the cage had 0.71 square feet of floor space. Each cage has a circular feeder and drinker to supply unlimited food and water.

3.9 Brooding

During the brooding stage, newspapers were placed on the brooder box's floor as bedding materials and they were replaced on a regular basis to avoid a damp floor from the birds' pee.

At the 1st, 2nd, 3rd, and 4th weeks, the brooding temperature was 95F, 90F, 85F, and 80F, respectively. The temperature was maintained by regulating the numbers of electrical bulbs with 100 and 60 watts of power. A room thermometer was used to record temperature and continuous lighting was given. Every brooding cage was equipped with a feeder and a drinker to guarantee that the birds had unlimited access to food and water.

3.10 Sanitation and cleaning

With caustic soda and tap water, the shed was thoroughly cleaned and washed . For disinfection, phenyl solution (0.5 percent v/v) was sprayed over the floor, corners, and ceiling. After the spray, cleaning was done with a brush and clean water. Brooding boxes, rearing cages, ceiling, feed holding racks, and fans were all cleaned in the same way. The house was given a week to dry properly after being washed and disinfected. After drying, all doors and windows were sealed. By combining formalin

and potassium permanganate, the room was fumigated for 24 hours. The next day, lime was spread on the floor and around the shed.

3.11 Watering and feeding

All of the materials for the feed were acquired from Chattogram and ration were made by combining various items in accordance with the composition of the baseline diet . The birds in the control groups were fed the basal food, whereas the treatment groups were fed jackfruit enriched feed, as shown in Table 2. The birds were given limited amounts of food and water. To eliminate feeding bias, each replication received the same number of feeders (one for each compartment) and drinkers (one for each compartment), as well as the same amount of feed and water. There were two types of feeders available: round (0-7 days) and linier type (8-35 days). Throughout the entire rearing period, the drinker was a circular kind with a 1.5 liter capacity.

Newcastle Disease (ND) and Infectious Bursal Disease (IBD) were routinely vaccinated in all of the birds. The vaccines were purchased from Division Livestock Office and transported in icebox to maintain the quality and function. To reduce stress, vaccinations were given early in the morning.

Table 4: Vaccination schedule

Age of birds	Name of diseases	Name of the vaccine	Route of administration
4th day	New Castle Disease	BCRDV (Live)	One drop in one eye
12th+day	Infectious Bursal Disease	IBD	One drop in one eye
18thday	Infectious Bursal Disease	IBD	One drop in one eye
21th day	New castle Disease	BCRDV (Booster)	One drop in one eye

3.12 Research Method

At weekly intervals, all of the experiment's required parameters were recorded. At the fifth week, the properties of the carcass were studied. Weight growth was measured by subtracting the birds' beginning body weight from their final body weight. Feed intake was determined by subtracting left over feed from the total amount of feed given to the birds. Feed intake was divided by weight increase to calculate FCR.

3.13 Characteristics of the Carcass

On the 35th day, 3 birds were chosen at random from each replication and executed. After adequate bleeding out, the birds were defeathered and treated as prescribed. During the evisceration surgery, the abdominal fat, liver, spleen, bursa, and gizzard were all removed and weighed separately. The weight of the dressed carcass was determined by weighing dressed birds. Total breast meat, thigh meat, and thigh bone weights were all recorded and calculated.

3.14 Biochemical analysis of serum

Blood samples were collected from the brachial veins of two birds from each replicate using a 5 mL sterile syringe and a 23-gauge needle. Each bird had a 5 mL blood sample drawn and immediately transferred to a sterile tube without anticoagulant. After centrifuging the clotted blood in the vacutainer tube at 3000 rpm for 20 minutes, the prepared serum was collected into the eppendorf tube using a micropipette. Standard kits (Bio Meraux, France) and an automatic analyzer (Homolyzer,300, Merck®, Germany) were used to measure different blood parameters (cholesterol, triglyceride, LDL and HDL) in the Post Graduate Laboratory under the department of Animal Science and Nutrition, CVASU, according to the manufacturer's instructions.

3.15 Chemical composition of meat

Different organs were taken and weighed precisely, and a sample of breast meat was obtained in a plastic zipper bag for analysis of proximate composition and oxidative rancidity of meat.

A comparable amount of breast flesh was macerated in a meat grinder and frozen at 20°C until analysis. Chemical analysis was performed on these samples using (AOAC, 2006). To evaluate the dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), and total ash (TA) of meat sample, the Nutrition Laboratory

of CVASU's Department of Animal Science and Nutrition conducted proximate component analysis.

3.16 Oxidative stability of meat

The thiobarbituric acid reactive substance (TBARS) levels of meat samples were measured when fresh, as well as after 1, 2, and 3 weeks, following the method published by (Hossain et al., 2012). A total of 4 g of meat was placed in an open-mouth test tube with 10 ml of solution 1 (20 percent trichloroacetic acid in 2M phosphoric acid) to calculate TBARS. 10 mL distiller water was added to dilute it. The fluid was then filtered using Double Rings-102 filter paper at a medium speed after being homogenized with a homogenizer (Model: SR-30, Medline Scientific Ltd., UK) and then the fluid was filtered at a medium speed using Double Rings-102 filter paper. 2 ml filtrate was combined with 2 ml solution-2, a distiller water solution containing 0.005 M 4,6 dihydroxi-2-mercaptopyridine. The test tubes are then placed in an 80°C water bath (Witeg, Germany, Digital Pricise Water bath®, Model: WB-22). After 30 minutes, the test tube are removed and allowed to cool at ambient temperature. The absorbance of the solution was then measured using a spectrophotometer with a wavelength of 530 nm (Model: U-2900, Hitachi® Ltd, Japan). The amount of TBARS in each 100 g of meat was measured in micromoles of malondialdehyde (MDA).

3.18 Statistical analysis

After collection, all the data were entered into MS Excel (Microsoft Office Excel-2013, USA) and analyzed by using the General Linear Model (GLM) procedure of SAS Institute (2003). Means showing significant differences were compared by Duncan’s New Multiple Range Test (Duncan 1955). The level of statistical significance was accepted at $P<0.05$.

Photo Gallery

Figure 1. Different experimental works**.**

Chapter 4: Results

The aim of this chapter is to present the findings of the assessment of dietary effects of dry and probiotic treated jackfruit by products on growth performance, serum lipid profile, meat quality in broiler.

4.1 Effects on growth performance

The growth performance of different treatment groups supplied with dried and probiotic treated jackfruit by products are shown in Table 5.

4.1.1 Growth performance

Results on live weight presented in Table 5 indicated a significant ($P<0.05$) increase in the final live weight in all treatment groups compared to control. The weekly average live weight increased in treatment groups while comparing to the control in every week, among which a significant increase was observed in 1st, 3rd and 4th weeks.

4.1.2 Average daily gain (ADG)

The data presented in Table 5 shows a significant ($P<0.05$) increase in overall average daily gain (ADG) in all treatment groups compared to that of control. The highest ADG was observed in 1st week in T4, 3rd week in T3, 4th week in T3 group than the control. The weekly ADG 1st, 3rd and 4th weeks showed dramatically improved in all dietary groups in contrast to 2nd week.

4.1.3 Average daily feed intake (ADFI)

The overall average daily feed intake (ADFI) presented in Table 5 showed no significant ($P<0.05$) variation among all dietary groups throughout the study period. The highest weekly ADFI observed at 4th week in T3 group and it was higher in control group which was not statistically significant ($P<0.05$).

Table 5: Effects of dry and fermented jackfruit by products on Growth performance of broiler.

Parameters	Treatments						P
	T0	T1	T2	T3	T4	SEM	Value
1st week							
Initial wt (g)	43.38	43.21	43.88	43.63	43.67	0.14	0.12
Final wt (g)	154.42 b	156.756b	156.51b	155.25b	167.63a	2.18	0.02
ADG (g/b/d)	15.87b	16.22b	16.07b	15.95b	17.71a	0.31	0.02
ADFI(g/b/d)	25.28	26.38	26.25	26.03	25.27	0.41	0.51
FCR (feed/gain)	1.59 a	1.62b	1.63a	1.63a	1.42b	0.04	0.04
2nd week							
Initial wt (g)	154.42b	156.75b	156.50b	155.25b	167.63 a	2.17	0.02
Final wt (g)	364.42	370.00	358.13	351.19	367.13	7.16	0.51
ADG (g/b/d)	30.00	30.47	28.80	27.99	27.99	0.98	0.52
ADFI(g/b/d)	53.1	55.10	54.76	52.13	51.84	2.05	0.80
FCR (feed/gain)	1.78	1.81	1.90	1.86	1.81	0.06	0.82
3rd week							
Initial wt (g)	364.42	370.00	358.13	351.19	367.13	7.15	0.51
Final wt (g)	693.21a	705.00 a	663.88b	709.75a	700.56a	7.57	0.04
ADG (g/b/d)	46.97 bc	47.86ab	43.68c	51.22a	47.63b	0.97	<0.001
ADFI(g/b/d)	89.69	86.35	88.43	88.78	87.25	1.49	0.72
FCR (feed/gain)	1.91ab	1.80b	2.03a	1.73b	1.73ab	0.05	0.06
4th week							
Initial wt (g)	693.21a	705.00a	663.88b	709.76 a	700.56 a	7.57	0.04
Final wt (g)	1136.59ab	1160.88 a	1072.69b	1216.88a	1185.25a	21.90	0.02
ADG (g/b/d)	63.34bc	65.13abc	58.40c	72.45a	69.24 ab	2.16	0.02
ADFI(g/b/d)	115.55	124.46	119.88	129.04	127.56	3.22	0.19
FCR (feed/gain)	1.83	1.92	2.06	1.78	1.85	0.08	0.19
5th week							
Initial wt (g)	1136.59ab	1160.88 a	1072.69b	1216.88 a	1185.25a	21.90	0.02
Final wt (g)	1621.88	1646.29	1536.69	1709.63	1670.75	31.75	0.08
ADG (g/b/d)	69.33	69.34	66.29	70.39	69.36	2.42	0.94
ADFI(g/b/d)	137.27	127.09	134.25	129.34	120.69	4.11	0.20
FCR (feed/gain)	1.99	1.84	2.03	1.89	1.74	0.12	0.59
Overall							
Initial wt (g)	43.38	43.21	43.88	43.63	43.67	0.15	0.12
Final wt (g)	1621.88	1646.29	1536.69	1709.63	1670.75	31.76	0.08
ADG (g/b/d)	45.103	45.80	42.65	47.60	46.49	0.90	0.08
ADFI(g/b/d)	84.20	83.87	84.71	85.06	82.52	0.69	0.29
FCR (feed/gain)	1.87	1.83	1.99	1.79	1.77	0.03	0.06

abcd Means with different super scripts in the same row differ significantly. Data indicated the mean value of 3 replications with 8 birds per treatment (n=24). T0 = Control (Basal diet);

T1=0.8% dry jackfruit by product +basal diet; T2=1.2% dry by product +basal diet; T3=0.8% fermented jackfruit by product +basal diet;T4=1.2% fermented jackfruit by product +basal diet. SEM=Standard error of means.

4.1.4 Feed conversion ratio (FCR)

The feed conversion ratio tabulated in Table 5 shows that there was a significant variation found (P<0.05) in overall FCR in all treatment groups except 2nd week. The lowest value was observed in 1st week in T4 group (1.42) and highest value was observed in 4th week in T3 group (2.06).

4.2 Carcass characteristics

Dietary effects of dry and probiotic fermented on jackfruit by products different carcass characteristics have been presented in Table 6. Relative weights of different components of carcass and organs calculated as a percentage of body weight, have been sequentially described according to different treatment groups. Live weights showed asignificant increase (P<0.05) in all dietary groups compared to control. The relative weight of thigh meat increased numerically in all treatment groups while comparing with control. Although other collected parts of carcass had no significant difference compared to control. The total lymphatic organs (liver, spleen and bursa) weight also showed an increase in weight in contrast to control, though the results were not significant statistically (P<0.05).

Table 6. Effects of dry and probiotic fermented jackfruit by products on carcass characteristics and organ weight.

Parameters (%)	**Treatment**					**SEM**	**P Value**
	T0	**T1**	**T2**	**T3**	**T4**		
Dressed weight	59.42^{b}	63.64^{b}	63.71^{b}	73.49^{a}	58.50^{b}	2.34	0.02
Breast meat wt	14.32	14.82	13.93	18.18	14.65	0.91	0.08
Thigh wt	4.55^{b}	4.33^{b}	4.14^{b}	5.65^{a}	4.17^{b}	0.29	0.03
Drumstick wt	5.00^{b}	4.85^{b}	4.12^{b}	6.83^{a}	4.80^{b}	0.39	0.04
Head wt	3.12^{a}	2.66^{ab}	2.56^{ab}	3.40^{a}	2.19^{b}	0.22	0.05
Spleen wt	0.07^{bc}	0.11^{ab}	0.06^{c}	0.12^{a}	0.09^{abc}	0.01	0.04
Heart wt	0.47	0.47	0.38	0.57	0.44	0.05	0.23
Bursa wt	0.14^{d}	0.20^{b}	0.18^{bc}	0.26^{a}	0.16^{dc}	0.01	<0.0001
Liver wt	1.50^{c}	1.98^{abc}	1.66^{bc}	2.46^{a}	2.03^{ab}	0.14	0.01
Gizzard wt	2.93^{b}	2.73^{b}	2.43^{b}	3.69^{a}	2.52^{b}	0.16	0.01
Abdominal fat wt	2.50^{a}	1.82^{bc}	1.13^{d}	1.98^{b}	1.53^{c}	0.11	0.0002

[abcd] Means with different super scripts in the same row differ significantly.
Data indicated the mean value of 3 replications with 8 birds per treatment (n=24). T0=Control (Basal diet); T1=0.8% dry jackfruit by product +basal diet; T2=1.2% dry by product +basal diet; T3=0.8% fermented jackfruit by product +basal diet;T4=1.2% fermented jackfruit by product +basal diet. SEM=Standard error of means.

4.3 Serum parameters

The changes in serum lipid profiles due to dry and probiotic treated jackfruit by product meal are presented in Table 7. The total cholesterol, HDL, LDL and TG contents were tested and compared between treatment groups with control.

Table 7. Dietary effects of dry and fermented jackfruit by products on blood serum parameters.

Parameters	Treatments					SEM	P Value
	T0	T1	T2	T3	T4		
Cholesterol (mg/dl)	117.62 [a]	102.10[b]	108.97[ab]	109.41 [ab]	104.76[b]	2.77	0.05
Triglyceride (mg/dl)	78.02[a]	69.09[a]	57.97[b]	54.38 [b]	58.12[b]	2.97	0.02
HDL (mg/dl)	64.46	63.17	68.50	72.27	67.69	4.04	0.59
LDL (mg/dl)	37.56	25.28	28.87	26.27	25.45	3.01	0.15

[abcd] Means with different superscripts in the same row differ significantly.
Data indicated the mean value of 3 replications with 2 birds per treatment (n=6). T0=Control (Basal diet); T1=0.8% dry jackfruit by product +basal diet; T2=1.2% dry by product +basal diet; T3=0.8% fermented jackfruit by product +basal diet; T4=1.2% fermented jackfruit by product +basal diet; SEM=Standard error of means.

The serum cholesterol level in different dietary treatment groups showed significant differences compared to control group ($P<0.05$). The lowest cholesterol level was found in T1 group. The HDL level increased in all treatment groups compared to control with highest value in T3 group than the control. The comparison of concentration of LDL in serum of treatment group with control shows that treatment T1 had the lowest level of LDL in serum. It revealed that the LDL level reduced significantly in all treatment groups except T2 when compared to control ($P<0.05$). The level of triglyceride in serum had dramatically declined in all treatment groups in

contrast to control group. The lowest value was obtained in T3 while the highest value was in control.

4.4 Chemical composition of meat

Dietary effects of dry and probiotic fermented jackfruit by products supplements on chemical composition of meat are represented in Table 8. The result shows that the moisture percentage significantly among all dietary groups. The highest and lowest value of moisture was observed in T3 and T2 group. The crude protein increased in T4 compared to control although other groups the value decreased. The ether and ash content showed significant change in T3 and T4 group among all dietary groups with control.

Table 8 : Dietary effect of dry and probiotic fermented jackfruit by products on proximate analysis of meat.

Parameters (%)	Treatments					SEM	P Value
	T0	T1	T2	T3	T4		
Dry matter	28.10 [a]	26.64 [b]	24.50 [c]	28.61 [a]	24.93 [c]	0.118	<.0001
Crude protein	21.99 [b]	21.64 [c]	21. 24 [d]	22.17 [b]	27.30 [a]	0.08	<.0001
Ether extract	0.90	0.94	0.79	0.98	0.67	0.06	0.0013
Ash	21.99 [b]	21.98 [b]	21.24 [c]	22.17 [b]	27.30 [a]	0.14	<.0001

[abcd] Means with different superscripts in the same row differ significantly.
Data indicated the mean value of 3 replications with 8 birds per treatment (n=6). T0=Control (Basal diet); T1=0.8% dry jackfruit by product +basal diet; T2=1.2% dry by product +basal diet; T3=0.8% fermented jackfruit by product +basal diet; T4=1.2% fermented jackfruit by product +basal diet; SEM=Standard error of means.

4.5 Oxidative stability of meat

The total effects of dry and probiotic treated jackfruit by products on TBARS value of breast meat of broiler kept at 4°C for 3 consecutive weeks (Table 9). A significant decrease was observed on fresh meat sample as well as at rest of the weeks ($P<0.05$). The lowest average TBARS value was observed in T4 group whereas the highest value was observed in control group.

The weekly TBARS value also exhibited significant in all treatment groups from control ($P<0.05$). However, at 1st week, the lowest TBARS value was observed in T1

group. The highest value of TBARS was constantly found in control group from fresh meat up to 3 consecutive weeks of refrigeration at 4°C.

Table 9. Weekly Thiobarbituric acid reactive substance (TBARS) value of meat in dietary groups (µmol MDA/100g of meat).

Parameters	Treatments					SEM	P Value
	T0	T1	T2	T3	T4		
Fresh	1.63[a]	1.13[b]	1.22[b]	1.20[b]	1.09[b]	0.06	.0045
1st Week	3.98 [a]	3.04[c]	3.21[b]	3.22[b]	3.08 [bc]	0.03	<.0001
2nd Week	6.12[a]	5.06[b]	5.14[b]	5.19[b]	5.25 [b]	0.05	<.0001
3rd Week	9.03[a]	8.14 [c]	8.11 [c]	8.77[b]	8.63[b]	0.04	<.0001

[abcd] Means with different superscripts in the same row differ significantly.
Data indicated the mean value of 3 replications with 8 birds per treatment (n=6). T0= Control (Basal diet); T1=0.8% dry jackfruit by product +basal diet; T2=1.2% dry by product +basal diet; T3=0.8% fermented jackfruit by product +basal diet; T4=1.2% fermented jackfruit by product +basal diet; SEM=Standard error of means.

4.6 Cost benefit analysis

The cost benefit analysis of the bird fed supplemented diets with dry and probiotic fermented jackfruit by products in comparison with control are given in Table 10. The net profit varied significantly (P<0.05) among all dietary groups compared to control. The profit per kg was highest in T3 group which was followed by T4.

Table 10: Cost benefit analysis of the bird fed supplemented diets with dry and probiotic fermented jackfruit by products.

Parameters	Treatment					SEM	P Value
	T0	T1	T2	T3	T4		
Feed intake(kg)/bird	2.95[a]	2.97a	2.98a	2.98a	2.98b	0.01	0.05
Feed cost/bird	107.66[a]	108.37[a]	108.80[a]	108.88[a]	104.57 [b]	0.61	0.05
Chick+vaccine+ labour cost	70.00[b]	70.00[b]	70.00 [b]	71.00[a]	71.00[a]	0	<.0001
Total cost(tk)	177.66	178.37	178.80	179.88	175.57	0.75	0.08

Live weight (g)	1614.96	1615.96	1616.00	1698.12	1652.92	48.44	0.71
LW/kg	1.62	1.62	1.615	1.70	1.65	0.04	0.69
Selling price	218.02	218.16	218.15	229.24	223.14	6.54	0.71
Net profit	40.35	39.79	39.36	49.37	47.58	6.27	0.71
Net profit/kg	24.77	24.41	24.21	28.	28.76	3.37	0.70

[abcd] Means with different superscripts in the same row differ significantly.

Data indicated the mean value of 3 replications with 8 birds per treatment (n=24). T0=Control (Basal diet); T1=0.8% dry jackfruit by product +basal diet; T2=1.2% dry by product +basal diet; T3=0.8% fermented jackfruit by product +basal diet; T4=1.2% fermented jackfruit by product +basal diet; SEM=Standard error of means.

Chapter 5: Discussion

The results of the present study, conducted for investigating the dietary effects of jackfruit by products both in dry and fermented form on growth performance, serum biochemistry, carcass characteristics, meat quality and oxidative stability, are discussedunder this chapter.

5.1 Weight gain

According to the results of the current study, weight increase in the various treatment groups exhibits a notable degree of improvement when compared to the control group. These results only confirm the report of Ravindran (2010) in which it was stated that jackfruit by products can be used as an alternative feed in poultry rations in which the objective is economic productivity rather than maximum biological productivity. According to the above author, jackfruit by products can be included up to 30% of poultry rations. Ironically however, the same author showed in one of his studies that inclusion of jackfruit by products in broiler rations depressed growth rate and even contributed to chick mortality. As explained, this is because of the presence of anti-nutritional factors including lectins in raw jackfruit seeds.

The possible reasons of *Artocarpus heterophyllus* Lam. for having promising effect on body weight in treated broilers might be due to its enriched phytochemical molecules with high nutritive value (Om Prakash et al., 2009) , broad antibacterial activity (Khan et al., 2003), antioxidant activity (Ko et al., 1998) and hepatoprotective effect (Saxena et al., 2016).

5.2 Feed intake

The average daily feed intake in this study showed no significant difference between the treatment groups with control. *Artocarpus heterophyllus* Lam. at 0.8% inclusion level (T_3) showed performance in feed intake compared to normal and positive control groups which indicated the pharmacological effects of herbs as adaptogenic, appetite stimulant, antioxidant and remunerating properties. The results of the present study are in accordance with the study of Al-Kassie *et al.* (2011). Increase in the weight of birds is an indication of bioavailability of

nutrients and quality of feed.

5.3 Feed conversion ratio (FCR)

In the current study, all treatment groups' feed conversion ratio (FCR) significantly decreased as compared to the control group. The lowest value was observed in T4 treatment group given 1.2% fermented jackfruit by products which was followed by T1 group (0.8% dry). According to Ferket and Gernat *(*2006a) FCR is the ultimate of all the productivity parameters used to assess broiler performance (Ferket and Gernat 2006b*)* add that in order for producers to attain the best FCR, the energy and protein intake should be of prime consideration. The results of the present study are in accordance with the study of Allinson et al., (2013) herbal extracts, which enhanced the performance and decreased the feed gain ratio by significantly decreasing the pathogenic bacterial and oocyst count in the gut and the hepatoprotective (Saxena et al., 2016*)*, nematodicidal (Arung et al., 2017), anti-ulcer (Om Prakash et al., 2015) and anti-bacterial (Jitendra et al., 2014) activities of broiler. *Artocarpus heterophyllus* would be the reasons for the improved feed conversion efficiency of the birds in this study. The results of the present study are in accordance with the study of Al-Kassie et al. (2011) and Issa and Omar (2012) in which broilers supplemented with herbs resulted in increased feed consumption due to improved efficiency of digestive organs, digestibility of crude protein and dry matter.

5.4 Serum biochemical parameters

In this study while measuring the lipid profile, a numerical decrease in serum cholesterol was found in treatment groups compared to control. Serum LDL and triglyceride level reduced significantly with which, serum HDL level increased in all treatment groups when compared to control. As the regulation of triglycerides is driven by the availability of free fatty acids (Schummer et al., 2008), an enhanced lipolysis could, as a consequence, increase the biosynthesis of plasma triglyceride. This statement is sustained by the decreased of LDL cholesterol which could indicate that induces reduction of LDL receptors for cholesterol, reducing the transport of cholesterol to cells and the risk of atherosclerosis. In terms of energy yielding potential, fat is not an essential dietary ingredient and may be replaced by carbohydrate. The hydrolysis of triglycerides yields glycerol and fatty acids, which serve as concentrated sources of energy (Esonu, 2006).

5.5 Carcass characteristics

The weight of different parts and visceral organs such as thigh weight, breast meat, abdominal fat, liver, spleen, and bursa showed no significant variation between dietary groups with control. Results in present investigation revealed that there was significant positive impact on cut up parts of broilers. Results of the present investigation were in accordance with the findings of Afolayan et al., (2008) who found better carcass and cut up yields in enzymes and probiotics supplemented group of broilers. The higher cut up yields observed in supplemented groups may be due to more edible muscle mass in broilers in enzymes and probiotic groups. The dressing percentage showed that there was no significant difference ($p>0.05$) between birds fed diets. This could also be due to quality and nutritional composition of the control diet.The nonsignificant difference ($p>0.05$) observed in the prime cut parts (breast, thighs, and drum sticks) across the treatment groups showed that with better processing methods, jackfruit seed meal could become better substitute for the expensive conventional feed stuff.

5.6 Oxidative stability of meat

Measuring the TBARS value of meat to measure the oxidative stability of the meat revealed that all treatment groups had lower TBARS values than the control. The lowest average TBARS value was observed in T4 group whereas the highest value was observed in control group. Both dry and probiotic treated group with higher jackfruit by products increased the oxidative stability of meat. Jackfruit also has been reported to contain antioxidant, pheonol, flavones (Ko et al., 1998). The results of a study carried out by Elkin (1995) suggested that the jackfruit possesses compounds with chemoprotective properties to reduce the mutagenicity of aflatoxin B1 (AFB1) and proliferation of cancer cells and the jackfruit flesh contains compounds that may be an effective aid to prevent or treat lymphoma between all treatment groups and the control the overall cost did not differ considerably. The previous studies of (Om Prakash et al., 2013) on the immunomodulatory effect of *Artocarpus heterophyllus* leaves extract for the treatment of opportunistic infections with the suspect of having immunomodulatory properties was proved in this study.

5.7 Chemical composition of meat

The Crude Protein represents 27.30[a] % of the total composition of the jackfruit by products in the present study. This value is higher than the other values observed in the *Artocarpus odoratissimus* (8.78%), A. altilis (8.12%) and A integer seed flour (Tukura and Obliva, 2015; Masri et al., 2017). Comparable values of 12.25-16.80% and 13.50% protein were also reported by (Eke-Ejiofor et al. 2014) and (Ocloo et al., 2010), respectively. In this study, the moisture content of the jackfruit by products was reported as 28.61 % lower than those obtained by (Azeez et al., 2015). Lower moisture content increased the shelf stability and the quality of the jackfruit by products. The differences in moisture content might have resulted from the different methods of the drying process and its duration employed in the preparation of the samples.

Conversely, the moisture value reported in this study was higher than the amount of 6.09% found by Ocloo et al. (2014). The reported ash content of the jackfruit by products used in this study was 27.30 %, in line to as reported by Ocloo et al. (2010) and Eke-Ejiofor et al. (2014), respectively.

5.1 Cost benefit analysis

Between all treatment groups and the control, the overall cost did not differ considerably. The previous studies of Om Prakash et al.(2013) on the immunomodulatory effect of Artocarpus heterophyllus leaves extract for the treatment of opportunistic infections with the suspect of having immunomodulatory properties was proved in this study. These findings are in agreement with the findings of Tekada et al. (2008*)* who studied the effect of jackfruit related to the healthcare.

Chapter 6: Conclusion

This research investigated the effects of Jackfruit by products both in dry and probiotic fermented form on growth performance, carcass characteristics, serum lipid profile, meat quality and oxidative stability of broiler meat for a period of 35 days. This study showed that inclusion of jackfruit by products in diets of broiler chickens was beneficial in improving growth, higher carcass yield, better feed efficiency and enhanced economic value especially at 0.8 % fermented level of inclusion. It is recommended that 0.8% fermented jackfruit by-products meal can be used in broiler diet since the level increased performance, reduced cost of production and had no deleterious effects.

Chapter 7: Recommendations

From this study it is concluded that, the *Artocarpus heterophyllus* Lam. showed significant results on growth and humoral mediated immunity in broilers. The phytocomponents identified in this plant as mentioned above could be the possible reasons for their promising growth promoting and potent immunopharmacological properties since they are proved as cytoprotective, immunostimulatory, antioxidant, apoptogenic, free radical scavenging, rejunuvating, antibacterial, anti-inflammatory, antidepressant, wound healing, anti-ageing and hepatoprotective. This study also recommends the usage of this herb as a supplement in broiler feed at 0.8% fermented level for better immunity. Further, the specific herbal constituents responsible for immunostimulant other dosage forms of this by toxicological investigation with special reference to meat quality and detailed immunological investigations including molecular aspects of immunology and immunehistochemistry can be ascertained in future.

Chapter 8: References

Afolaya MO, Afolayan M. 2008. Nigeria oriented poultry feed formulation software requirements. Journal of Applied Sciences Research. 4(11): 1596–1602.

Ahmad I. 2006. Effect of probiotics on broilers performance. International Journal of Poultry Science. 5 (6): 593–597.

Akinmutimi AH. 2003. The effect of various processing method on proximate, gross energy and mineral composition of Mucuna utilis seed. Procedure of the Nigerian Science of Animal Production. Held at IAR and T Ibadan. Pp. 166-168.

Aletor VA, Fasuyi AO. 1997. Nutrient composition and processing effects on cassava leaf *(*Manihot esculenta, cranzi*)* anti-nutrients. A paper presented at the 2nd Annual Conference of Animal Science Association of Nigeria, Lagos. Pp. 231- 242.

Allison IB, Equisetin DA, Asola AA, Opunake IM, Njoku CP. 2013. Effect of herbal supplement on growth response and fecal egg counts of cockerels. Online Journal of Animal Feed. 3(3): 68-73.

Angulo FJ, Nagrand VN, Chiller TC. 2004. Evidence of an association between microbial agents in food animals and anti-microbial resistance among bacteria isolated from humans and the human health consequences of such resistance. Journal of Veterinary Medicine Series Infectious diseases and Veterinary Public Health. 51(8-9): 374-379.

AOAC.1990. Association of Analytical Chemists. Official Methods of Analysis 5th ed. Washington DC.

Apata DF. 2008. Growth performance nutrient digestibility and immune response of

broiler chicks fed diets supplemented with a culture of Lactobacillus bulgaricus. Journal of the Science of Food and Agriculture. 88 (7): 1253 - 1260.

Araújo NG, Lima LRP. 2010. Utilizers de Artocarpus heterophyllus treatments the calculus oxalate de calciol journal 22(11-12): 3-7.

Arung ET, Shimizu K, Kondo R. 2017. Structure-activity relationship of prenyl-substituted polyphenols from Artocarpus heterophyllus *as* inhibitors of melanin biosynthesis in cultured melanoma cells. Association of Chemical Biodiversity. 4(9): 2166-2171.

Azeez SO, Lasekan O, Jinap S, Sulaiman R. 2015. Physicochemical properties, amino acid profile and antinutritional factors in seeds of three Malaysian grown jackfruit cultivars. Journal of Food Agriculture and Environment. 13(2): 58–62.

Al-Kassie GAM, Mohseen AM, Abd-Al-Jaleel RA 2011. Modification of productive performance and physiological aspects of broilers on the addition of a mixture of cumin and turmeric to the diet journal 10(1): 31-34.

Byarugaba D. 2007. The structure and importance of the commercial and village-based poultry systems in Uganda. Kampala, FAO. (Consultancy report), 2007.

Casburn-Jones AC. Farthing MJG 2004. Management of Infectious Diarrhoea. 53(2): 296- 305.

Castanon JIR. 2007. History of the use of antibiotic as growth promoters in European poultry feeds. Journal of Poultry Science. 8 (9): 905–909.

Centers for Disease Control and Prevention CDC. 2004. Morbidity and mortality weekly report. Diagnosis and management of foodborne illnesses: safer, healthier people. Atlanta.

Douglas JH, Sullivan TW, Abdul Kadir R, Ruprow JH. 1992. Influence of infrared (Micronization) treatment on the nutritional values of corn and low and high tannin. Sorghum Poultry Science. 70(2): 1534–1545.

Eburuaja AS, Onunkwo DN, Odukwe CN, Onuachu JC. 2017. Performance of broiler chicken fed raw and jackfruit seed meal (*Artocarpus heterophyllus*). Nigerian Journal of Animal Production. 44(2): 145-151.

Eke EJ, Beleya EA, Onyenorah NI. 2014. The effect of processing methods on the functional and compositional properties of jackfruit seed flour. International Journal of Nutrition and Food Sciences. 3(3): 166–173.

Elkin RG, Roggler JC, Sullivan TW. 1995. Differential response of ducks and chicks to dietary sorghum tannins. Journal of Science and Feed Technology. 10 (8): 23–25.

Ferket PR, Gernat AG. 2006. Factors that affect feed intake of meat Birds: A review Asian network for scientific information. International Journal of Poultry Science. 5(10): 905–935.

Eyoh, GD, Udo, MD and Edet CP. (2019). Growth performance and carcass characteristics of west african poultry fed different forms of processed guinea grass (Panicum maximum).

Godfray HCJ, Beddington JR, Crute IR, Haddad L, Lawrence D, Muir, JF 2010. Food security: The challenge of feeding 9 billion people; 327: 812-818.

Gangwar SS, Chaudhary LC, Agarwal N, Nath R, Kamra DN. 2018. Effect of leaves containing bioactive compounds from north eastern region of India on in vitro fermentation and methane production. Animal Nutrition and Feed Technology. 18 (3): 451–458.

Haghighi HR, Gong J, Gyles CL, Hayes MA, Sanei B, Parvizi P, Gisavi H, Chambers JR, Sharif S. 2005. Modulation of antibody-mediated immune response by probiotics in chickens. Clinical and Vaccine Immunology. 12 (12): 1387–1392.

Jagtap UB, Bapat VA. 2010. Artocarpus: A review of its traditional uses, phytochemistry and pharmacology. Journal of Ethnopharmacology.129(2) : 142-166.

Jin LZ, Ho YW, Abdullah N, Jalaludin S. 1997. Probiotics in poultry modes of action. World's Poultry Science Journal. 53 (4): 351–387.

Jitendra R, Kalpana S, Shweta S, Kumar MS, Manish B. 2014. Artocarpus heterophyllus (Jackfruit) potential unexplored in dentistry. An overview of University Journal of Pharmacology. 03(01): 50-55.

Kabir S. 2009a. Effect of probiotics on broiler meat quality. African Journal of Biotechnology. 8 (15): 3623–3627.

Kabir SM. 2009b. The role of probiotics in the poultry industry. International Journal of Molecular Sciences. 10 (8): 3531–3546.

Kabir SML, Rahman MM, Rahman MB, Ahmed SU. 2004. The dynamics of probiotics on growth performance and immune response in broilers. International Journal of Poultry Science. 3: 361-364.

Kumprecht I. 1998. The effect of probiotic preparations containing *Saccharomyces cerevisiae* and *Enterococcus faecium* in diets with different levels of B-vitamins on chicken broiler performance. Czech Journal of Animal Science. 43 (2): 63–70.

Kamruzzaman SM, Kabir SML, Rahman MM, Islam MW, Reza MA. 2005. Effect of probiotics and antibiotic supplementation on body weight and

haemato- biochemical parameters in broilers. Bangladesh Journal of Veterinary Medicine. 3(2): 100–104.

Khan MR, Omoloso Kihara M. 2003. Antibacterial activity of *Artocarpus heterophyllus.* Fitoterapia. 74(5): 501- 505.

Ko FN, Cheng ZJ, Lin CN, Teng CM. 1998. Scavenger and antioxidant properties of phenyl flavones isolated from *Artocarpus heterophyllus*. Free Radis Biological Medical. 25(2): 160-168.

Loizzo MR, Tunis R, Chandrika UG, Abeysekera AM, Menichini F, Frega NG. 2010. Antioxidant and antibacterial activities on foodborne pathogens of Artocarpus heterophyllus lam. (Moraceous) leaves extracts. Journal of Food Science. 75(5): M291-M295.

Madaleno IM. 2011. Plantas da medicina popular de São Luís, Brasil. Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas. 6(2): 273-286.

Mahajan P, Sahoo J, Panda PC. 1999. Effects of probiotic feeding and seasons on the growth performance and carcass quality of broilers. Indian Journal of Poultry Science. 34 (2): 167–173.

Masri N, Mansoor AH, Mamat H. 2017. Proximate composition, mineral content and functional properties of Tara (Artocarpus fortissimos) seed flour food Research journal. 1(3): 45-90.

Mountzouris KC, Paraskevas V, Fegeros K. 2010. Phytogenic compounds in broiler nutrition. Phytogenic in Animal Nutrition: Natural Concepts to Optimize Gut Health and Performance. Nottingham University Press. Nottingham, UK: 97–110.

Nwofia GE, Ojimelukwe P, Eji C. 2012. Chemical composition of leaves, fruit pulp and seeds in some Jackfruit by products (L) morphotypes. International Journal of medicinal and aromatic plants. 2 (1): 200–206

Ndyomugyeny EK, Kyarisiima CC, Bareeba FB, Okot MW. 2008. Evaluation of the nutritional value of boiled Java plum beans in broiler chick diets. Livestock based rural development. 67(3): 243- 276.

Ocloo FCK, Bansa D, Boatin R, Adom T, Agbemavor WS. 2010. Physicochemical, functional and pasting characteristics of flour produced from Jackfruits (*Artocarpus heterophyllus)* seeds. Agriculture and Biology Journal of North America. 1(5) : 903–908.

Ocloo FCK, Okyere AA, Asare IK. 2014. Physicochemical, functional and pasting properties of flour produced from gamma irradiated tiger nut (Cyperus esculentus L). Radiation Physics and Chemistry. 10(3): 9–15.

Om Prakash, Jyoti, Kumar A, Kumar P. 2013. Screening of analgesic and immunomodulator activity of Artocarpus heterophyllus Lam. leaves (Jackfruit) in mice. Journal of Pharmakos and Phytochemical. 1(6): 33-36.

Om Prakash, Kumar R, Chandra D, Kumar A, Kumar P. 2015. Effect of Artocarpus heterophyllus Lam. (Jackfruit) on indomethacin induced ulcer model in albino rats. Der Pharmacia Letters. 7(1): 81-85.

Prakash O, Kumar R, Mishra A, Gupta R. 2009. Artocarpus heterophyllus (Jackfruit): An Overview Pharmacognosy Reviews. 3(6): 353-358.

Ravindran V. 2010. Poultry feed availability and nutrition in developing countries. Available from: http://www.fao.org/docrep/013/al706e/al706e 00.pdf

Ravindran VG, Ravindran, Sivakanesan R. 1996. Evaluation of the nutritive value of jackseed (*Artocarpus heterophyllus*) meal for poultry. The Journal of Agricultural Science.12(7): 123–130.

Riyadh Al, Rahman A, Miah MG, Saha R, Hoque MA, Rahman MM, Miyajima I. 2020. Performance of spices as lower storey crop in jackfruit–papaya

multistorey agroforestry system in Bangladesh. Journal of the Faculty of Agriculture, Kyushu University. 65 (2): 223– 231.

Robberts KM, Daryi KG, Peter AM, Victor WR. 2006. Happers illustrated biochemistry 27th Edition. MC Graw-Hill, New York, USA.

Saxena K, Irchhaiya R, Chagti KK. 2016. Antihepatotoxic effect of Artocarpus heterophyllus leaves against paracetamol induced hepatic damage in albino rats. International Journal Pharmaceutical Life Science. 7(2): 4895-4899.

Schumer S, Chandra SBC, Hegde M, Narayanaswamy P. 2008. Evaluation of genetic diversity in jackfruit (Artocarpus heterophyllus Lam.) based on amplified fragment length polymorphism markers. Genetics and Molecular Research, 7, 6.

Siqueira J. 2006. Bioinvasão vegetal: dispersão e propagacão de espécies nativas e invasoras exóticas no campus da Pontifícia Universidade Católica do Rio de Janeiro (PUC-RIO). Revista Pesquisas, Botânica (57): 319-333.

Soumya k, Krishnamoorthy A, Patil P, Venkatesha MG. 2015. Evaluation of jackfruit germplasm against jack shoot and fruit borer, Diaphania caesalis (Wlk.) (Lepidoptera: Pyralidae). Pest Management in Horticultural. 67(3): 56-78.

Sun G, Zheng Z, Lee MH, Xu Y, Kang S, Dong Z, Wang M, Gu Z, Li H, Chen W. 2017. Chemoprevention of colorectal cancer by artocarpin a dietary phytochemical from *Artocarpus heterophyllus*. Journal of Agricultural and Food Chemistry. 65(17): 3474-3480.

Tamma SML, Chug KW, Patel T, Balan SP, Pahwa S. 2006. p38 MAPK plays a role in IL-4 synthesis in jacalin plus CD28-stimulated CD4+ T cells--II. Journal of Leukocyte Biology. 79(6): 1339-1347.

Tekade SH, Mode SG, Waghmare SP. 2008. Effect of *Asparagus racemosus*, sida cordifolia and Levamisole on immunological parameters in experimentally induced immunosuppressed broilers. Veterinary World. (2): 49-50.

Trindade MB, Lopes JL, S Soares-Costa, A Monteiro Moreira AC, Moreira RA, Oliva ML, V, Beltramini LM. 2006. Structural characterization of novel chitin-binding lectins from the genus Artocarpus and their antifungal activity. Proteins and Proteomics. 1764 (1): 146-152.

Tukura BW, Oliva O. 2015. Proximate and nutritional compositions of breadfruit (*Artocarpus altilis*) seeds. IOSR Journal of Environmental Science. 9(3): 2319–2399.

Van Vuuren, Viljoen A. 2011. Plant-based antimicrobial studies methods and approaches to study the interaction between natural products. Journal 77(11): 1168-1182.

Wei BL, Weng JR, Chiu PH, Hung CF, Wang JP, Lin CN. 2005. Anti-inflammatory flavonoids from *Artocarpus heterophyllus* and Artocarpus communis. Journal of Agricultural and Food Chemistry. 53(10): 3867-3871.

World Health Organization (WHO). 2015. Areas of work Databases Document centre WHO estimates of the global burden of foodborne diseases: Foodborne diseases burden epidemiology reference group 2007-2015, Switzerland.

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