

Chapter One

1.0 INTRODUCTION

Growth of poultry industry accompanied by a considerable increase in poultry productivity resulted in radical change of methods of feeding and rationing of nutrients. The structure of poultry rations has changed as well. However, a tendency is observed towards the reduction of the amounts of grain and fish meal as most deficient components in poultry rations. Work is under way to find various substitutes and to develop new synthetic additives (aminoacids, vitamins, antibiotics, microelements, (Vladimirova 1978).

Sudan recognized the potential of poultry industry in early fifties of last century were imported brooders was brought to Sudan by government and private sector subsequently peasants recognized the potential of including poultry production in their farms, this was further accelerated by urban development after country independence 1956, Region, Sudan Vision daily. com(2012).

The tremendous progress in the development of poultry industry in Sudan during recent decades is expected to continue further. This rapid growth in

terms of production and consumption has played a vital role in providing food for the rapidly growing human population of Sudan . Feed cost usually contributed 65-70% of the total cost of broiler production, but any increase in the total cost of feedstuffs is adversely affecting the growth rate of this industry. This situation becomes alarming particularly in case of various animal and vegetable protein sources that constitute 25-35 percent of broiler feeds. This increasing demand for protein supplements has compelled the researchers to find some non-conventional protein sources or some other alternative recycling of certain wastes, the conventional animal protein sources contribute about 25 percent of total protein and 8 percent of total energy in broiler rations . At present concentrate is the source of animal protein in practical broiler rations. The price of poultry concentrate varies considerably throughout the year . This invites the attention to look for an appropriate alternative source for concentrate (either partially or completely).Today the poultry industry of Sudan operates on a much larger scale. As the poultry industry expands, the day old chicks production per hatchery also increases.Hatchery waste normally refers to all of the collectible material

remaining in commercial hatching trays after saleable chicks have been transferred to farm. This waste includes shells from hatched chicks, infertile eggs, dead embryos still in the shell and dead chicks. In some cases, the shells from hatched chicks are separated, thus segregating the wastes into dry and wet residues (Hamm and Whitehead, 1982). Processed HW is a good source of energy, (Rasool et al, 1999) and Calcium and low Phosphorus (Dufloth et al., 1987). Different techniques for making meal from HW include dehydration, cooking with water, toasting, autoclaving, fermentation and extrusion (Vande Populiere et al. , 1977).The analysis of HWM revealed that it contains about 44.25% crude protein, 30.01% ether extract, 1.90% crude fiber , 14.04 % ash , 9.80% nitrogen free extract, 4572 Kcal gross energy and 3600 Kcal metabolizable energy (Rasool et al , 1999). HW is a rich protein source and showed steadily production increase due to the increase in hatchery houses for production of day old chicks in Sudan, this encouraging production of local non-conventional animal protein sources as an alternative feed resource. Therefore, the aim of this study is to study the effect of feeding different levels of hatchery waste on broiler chickens performance.

Chapter Two

2.0 LITERATURE REVIEW

2.1 Poultry Feed Resources:

The feed resources can be divided into two main categories as conventional and non-conventional. Conventional feed resources are those traditionally used. Whereas, the non-conventional are not commonly and traditionally used as chickens feed (Younas and Yagoob, 2005). However, conventional feed resources are facing a problem of competition with human foods, Gura (2008) stated also that the recent feed price increment may upset many of the plans to further development of industrial poultry production.

2.1.1 Conventional Protein Resources:

After energy sources raw materials, protein supplements constitute the largest component of poultry diets. Plant protein sources supply the major portion of dietary protein requirements. The plant protein source traditionally used for feed manufacture is soybean meal, which is the preferred source for poultry feed. Soybean meal contains 40 to 48 percent crude protein, depending on the amount of hulls removed and the oil extraction procedure. Relative to other

oilseed meals, soybean protein has a good balance of essential amino acid, which can complement most cereal-based diets. (www.Fao.org..poultry,2013).With the notable exception of soybean meal , plant protein source are generally nutritionally imbalanced in terms of essential amino acids, particularly lysine, the first limiting amino acid in cereals .Unless supplemented with animal protein sources and crystalline amino acids, plant-based diets may not meet the requirements for critical amino acids for egg and meat production. Owing to their high prices, animal protein ingredients are normally used to balance the amino acid contents of diets rather than as major sources of protein, (www.Fao.org..poultry,2013).

2.1.1.1 Groundnut Cake

The seeds of ground nut are borne in pods, usually in pairs or three. The seeds contain 250- 300 g/kg of crude protein and 350-600 g/kg of total fats. The most common method of extraction is screw pressing, giving a meal with 50-100 g/kg of oil. The composition of the meal depends on the raw material and the method of extraction used. The protein of ground nut meal has suboptimal amounts of cystine and methionine , although the first limiting amino acids is

lysine . The toxic factor was shown to be a metabolite of the fungus, *Aspergillus flavus* and was named aflatoxin. (McDonald et al 2002)

2.1.1.2 Cotton Seed Cake

The protein of cotton seed cake is of good quality but has the common disadvantage of oil seed protein of having a low content of cystine, methionine and lysine and calcium contents (McDonald et al 2002).

2.1.1.3 Sesame Cake

The meals currently available may be produced by hydraulic pressing or solvent extraction. The former have the lower protein content (about 400g/kg DM compared with 500g/kg for the solvent). The protein is rich in leucine, arginine and methionine but relatively low in lysine. (McDonald et al., 2002).

2.1.1.4 Soya bean meal

Soya beans contain from 160 to 210 g/kg of oil when normally solvent extracted the residual meal has an oil content of about 10g/kg. The meal is generally regarded as one of the best sources of protein .Soya bean meal

contains a number of toxic (McDonald et al 2002).

2.1.1.5 Fish meal

Fish meal is produced by cooking and pressing the cooked mass to remove most of the oil and water. The composition of the protein is rich in the essential amino acid, particularly lysine, cystine, methionine and tryptophan. Fish meals have a high mineral content (100-220g/kg), which of nutritional value since it contains a high proportion of calcium and phosphorus. (McDonald et al., 2002).

2.1.2 Non-Conventional Protein Resources:

2.1.2.1 Blood meal

Blood meal is a by-product from slaughter houses. Much of it is condemned, but it can be processed, as valuable protein source for animals. This usually made by coagulating the blood by steaming or by boiling, collecting the coagulates then drying and milling. Blood meal is one of the richest sources of arginine, methionine, cystine and leucine but is deficient in isoleucine and contains less glycine than either fish, meat or meat and bone meals (McDonald et al 2002).

2.1.2.2 Feather meal

Feather meal is a by-product of poultry processing. Since feathers are not digested by simple stomach animals, it should be hydrolyzed at high temperature under sufficient pressure, if a highly digestible product is to be obtained. The product has good keeping quality. It is rich in glycine, cystine, phenylalanine, but deficient in methionine, lysine, histidine and tryptophan. It therefore requires to be balanced with synthetic amino acids (McDonald et al., 2002)

2.1.2.3 Meat and bone meal

Meat and bone meal is an excellent source of protein. In poultry diets, meat and bone meal is typically limited to less than 5% of the diet because of the high calcium, phosphorus and lysine content of the meal. (Jacquie Jacob, 2015)

2.1.2.4 Poultry offal Meal

In addition to feather meal, there is another by-product produced from poultry processing. This is referred to as poultry by-product meal and consists of the products after dry rendering of the feet, head and intestines. This is also a valuable protein source (McDonald et al., 2002).

2.1.2.5 Poultry manure

Poultry manure, consists of the dry excreta, and the feathers and broken egg that drop into beneath the poultry cages. It is a useful product for crop cultivation. It can also be used as a valuable feedstuff and considerable potential exists to be incorporated in the diet of farm livestock. Poultry manure vary considerably in composition, depending upon their origins, poultry waste must by law, carry a declaration of the amount of protein equivalent of uric acid of 1 percent or greater and of calcium if in excess of 2% (McDonald et al., 2002) .

2.1.2.6 Hatchery Waste Meal (HWM)

The modern poultry production chain incorporates centralization of supervision and in some instances the physical facilities for the breeding flocks, hatchery-grow out and further processing is limited. Production in each of these sectors has resulted in considerable amount of waste and processing residue, including dead birds on the farm, hatching waste, feathers from processing plants and bone residue from production of mechanically deboned meat. Effective

handling of these wastes and residues poses a challenge to industry. The present poultry industry is more commercial and technically more advanced than it was a decade ago. Unfortunately, this intensive poultry production and processing has resulted in the production of large volumes of by-products like manure, dead or rejected carcasses, hatchery waste (HW) (Vande, 1976).

The poultry industry produces large amounts of hatchery waste which includes solid waste and wastewater. The solid hatchery waste comprises empty shells, infertile eggs, dead embryos, late hatchings and dead chicks. (Vande, 1976).

2.2. Handling and Treatment of Hatchery Waste

2.2.1 Systems of Transfer Hatchery Waste:

Some hatcheries store the waste in a cool room and then place the waste into a Bio-Bin. Other hatcheries will crush the waste first, then use a vacuum or auger system to transfer waste into the bin. In the USA, one disposal option is to transport the hatchery waste to a facility that separates the liquids from the solids by using a centrifuge.(Cawthon, 1998).

2.2.2 Separation of hatchery waste at the hatchery

Hatchery waste can be separated into solid and liquid components and then treated separately. For example the liquid in the hatchery waste can be separated from the solid hatchery waste by spinning, (Phililips, 1996). In addition inclined screens, followed by the use of belt or filter presses can be used for separation of solid and liquid portions of the waste. These methods produce about 45% of solid materials (Van slyke, et al., 2005). In other industries a flexible multi-layer filter can be used to separate liquid wastes from sludge wastes. The principle of this process relies on liquid waste passing through the liner into the container by gravity,(Schilling and Mintz, 2011) .Another system for separating liquid and solid waste is to use a conveyor with an upper and lower conveyor roller and an endless conveyor belt extending around the conveyor rollers. A waste deflector extends above and along the lowest portion of the upper run. Liquid and solid wastes are separated and placed in collectors which are located near the upper and lower rollers. (Van Slyke, 2007).

2.2.3 Separating egg shells from hatchery waste

A powerful suction vacuum is used to remove the dry, very light shells from the hatchery waste, leaving the heavier infertile eggs (World Intellectual Property Organization, 2002). The shell and non-shell material can also be separated by using a vibrating or shaking device (e.g. shaker – sieve belt), which can separate lighter parts from heavier parts in the hatchery waste. A stream of gas (such as a cyclone forced-air separator) also can be used to separate lighter materials from heavier materials in hatchery waste. After hatching, live chicks and unhatched chicks or clear eggs from the hatching tray are placed on a moving belt with fixed gaps that only allow chicks to slide through, while shells and unhatched eggs are retained on the belt. Then the shell is vacuumed up for further separation, with the dead embryos being disposed into a separate container (World Intellectual Property Organization, 2002).

2.3 Methods of recycling egg shells

Eggs shells can be composted with other organic materials to increase the mineral content of the compost .Other minor uses for crushed egg shells

include : 1) spread around plants to deter slugs and snails , 2) mixed with garden soil for use as a fertilizer ,3) fine pieces of crushed egg shell mixed with seeds for use as a feed for aviary birds ,4) added to cement to increase its strength ,5) used by artists to make textured paint for 3D effects in art work . (Bayan ,2011) .Complete separation of the membrane and the shell increases the value of the resulting products .One method is to use a meat processing machine to grind egg shells into a powder, and then mix the powder with water to separate the membrane . The shell sinks and the membrane stays suspended in the water .Another method is to place the egg shells in to a tank containing a fluid mixture and use cavitations (vapors bubbles in a flowing liquid) in the fluid mixture to separate the shell membrane. The fluid mixture is ideally recirculated to continue the separation process. (Vlad, 2011).

2.4 Disposal methods for solid hatchery waste

Most of the hatchery waste is sent to land fill or composting, which costs the chicken meat industry millions of dollars each year in disposal costs (Das.,et al ,2002). Some of the hatchery waste is rendered. The methods for wastewater disposal include sending it to land fill, using it for irrigation, disposing it

directly into the sewer or into a waste water lagoon. Some hatcheries use a wastewater treatment system. Land fill hatchery waste will break down naturally and produce methane which escapes to the atmosphere. Capturing and using the methane to prevent its release to air is beneficial to environment since methane has 21 times more global warming capacity than CO₂ (Climate Change Homepage , 2011).

2.5 Processing of Hatchery Waste

2.5.1 Rendering

The rendering process simultaneously dries the material and separates the fat from the protein to yields fat and protein meal (e.g., hatchery waste by-product meal) similar to meat and bone meal or fertilizer, (Salminen et al., 2002).

2.5.2 Autoclaved and extruding

Extruded autoclaved hatchery waste could be used as livestock feed. Said (1996) reported that dry extrusion was an effective method to treat hatchery waste. Miller (1994) extruded a mixture of ground hatchery and yellow maize meal (25:75) at 140C° for 10 s, while Lilburn et al, (1997) autoclaved turkey hatchery waste for 15 min at 125 °C to 5th pressure of 1.76 kg/cm² and then

dried it at 50 C° for 1 hour. Similarly Verma and Rao (1974) autoclaved hatchery waste (infertile eggs with dead embryos) and dried it at 100 C° for 10 h. Ravindra-Reddy and Rajasekhar-Reddy (1985) autoclaved day old cull male chicks for 30 min , the product was dried powdered and used as poultry feed.

2.5.3 Boiling

Hatchery waste could be treated in same way as poultry waste (feathers, heads, feet and inedible entrails (intestine, lung, spleen) by Boiling at 100 °C with pressure of 2.2 kg/cm² for 15 min, then boiled again at 100 C ° for 5 hours, followed by boiling at 130 °C for 1 h. and then cooked to ambient temperature (Kirkpinar et al., 2004). Likewise dead embryos could be boiled for 100 C° for 30 min and soaked in cold water for 30 min. to remove shell, sun dried for 4days and used in poultry feed (Abiola et al,2004). Cooking hatchery waste with water (2:1) then dehydrating to a dried product has been used as livestock feed (Ilian and Salman,1986 ;Rasool et al., 1999).

2.5.4 Ensiling

Kompianing (1994) reported a method of ensiling rejected hatchery eggs. The eggs mixed in 1:1 ratio with formic and propionic acids for 8 weeks at room

temperature .Formic acid is suitable for the ensiling of materials such as wet and protein –rich resources propionic acid and formic acid have been used to preserve non fertile eggs and dead embryos. The acids act by intervening specifically in the metabolism of the microorganisms. The rapid reduction in the pH diminishes the growth of bacteria which produce butyric acid and ammonia and promotes the growth of lactic acid –producing bacteria. The lactic acid is responsible for the low pH necessary for storage of the by-product before being used in animal feed.

2.5.5 Enzyme or sodium hydroxide treatments

Kim and Patterson (2000) treated culled birds for 12 h at 21 C° with 25.6 mg of enzyme or 2h at 21 C° in 0.4 N NaOH . The resulting product was fermented (with added sugar) for 21 days. After fermentation the products were autoclaved at 127 C° for 90 min. then dried in a forced-air oven at 124°C and the final product was used as poultry feed (Kim and Patterson ,2000).

2.5.6 Composting

Composting is a common method for solid organic waste disposal (Imbeah,1998 ;Cambardella, etal ,2003). In this process, mesophilic and

thermophilic micro-organisms convert biodegradable organic waste into a value added product (Imbeah, 1998;Lau, et al., 1992 and Liao, et al.,1993). The decomposition of organic waste is performed by aerobic bacteria, yeasts and fungi. The composting process kills pathogens, converts ammonia nitrogen to organic nitrogen and reduces the waste volume (Imbeah ,1998). The product can be used as a fertilizer .Das et al (2002) reported that composting hatchery waste with sawdust and yard trimming in a ratio 3:2:1 or composting it with sawdust, yard trimming and poultry litter in a ratio 2:1:1:2 eliminated 99.99 % of E.coli. Composting with litter also eliminated Salmonella, but Salmonella was present if temperature was too low (Das et al., 2002).

Composting hatchery waste with poultry litter produces a product that contains 1% nitrogen, 2.5% phosphorus and 0.25 % potassium on a dry weight basis. The potential method for treating hatchery waste on a hatchery site is to use an "in-vessel" composting technique to decompose and stabilize the un-separated hatchery waste obtained directly, from the hatchery. The hatchery waste can be mixed with wood shavings to reduce the moisture then composted (Cawthon, 1998).

2.5.7 Toasting

This type of cooking was carried out without addition of water . After cooking to certain level of dryness, the toasted material was transferred to an oven and dried at 60°C. Dried meal was then ground in laboratory mill for further use, (Saima,2001). Rassol et al (1999) simply toasted the HW in an open vessel without addition of water .

2.5.8 Formalin treatment

Raw HW was divided into three parts and these three parts were treated with 0.5, 1 and 2 percent levels of formalin solution. The treatment continued in an airtight vessel for about 24 hours to complete the action of formalin. The treated HW was transferred to an open vessels for evaporating formalin by toasting . The meal was then dried in an oven at 60°C (Saima, 2001).

Lilburn et al (1997) reported that during application of low temperature high pressure treatment, hatchery residues are subjected to 125°C along with 1.76 Kg/cm² pressure for 15 minutes. Ristic and Kormanjos (1988) involved autoclaving at 135°C for 15 minutes followed by drying at 95°C.

2.6 Chemical Composition of Hatchery Waste (HW).

The analysis of HWM revealed that it typically contains about 44.25 percent crude protein, 30.01 percent ether extract, 1.90 percent crude fiber , 14.04 percent ash , 9.80 percent nitrogen free extract, 4572 Kcal gross energy and 3600 Kcal metabolizable energy (Rasool et al , 1999) . Kundu, et al (1986) reported that hatchery – by product meal has 42.26 % crude protein, 0.96 % fiber, 10.13 % nitrogen free extract and 3.9 % ash. Hatchery waste is a high protein waste with 43–71% moisture, (Hamm and Whitehead, 1982 and Vande Populiere et al., 1977) . Dried hatchery waste contains 33.1% crude protein (CP), 29.0% ether extract, 12.1% crude fiber, 21.5% ash and 28.8 MJ/kg of gross energy (Sharara, et al, 1977). Apparent metabolisable energy (AME) of the hatchery waste by-product meal is 23.9 MJ/kg (Sharara et al, 1992).and the apparent amino acid availability of the hatchery waste by-product meal is 73% (Sharara et al, 1993).Nutritive value of the dried dead embryos is 36% CP, 27% ether extract, 17% ash, 10% calcium and 0.6% phosphorus (De Souza et al.,1978).

Kundu et al(1986) reported that when hatchery by- product meal was

prepared by boiling in water for about 30 minutes the meal showed some differences composition when dried at 100C° for 20 hours. This meal contains crude protein 42.26%, crude fiber 0.96%, ether extract 42.15% , nitrogen free extract 10.13% and ash 3.90% .The resultant meal by the dehydration process revealed that it contained crude protein 44.25%, ether extract 30.01% crude fiber 1.90%, ash 14.04 % , nitrogen free extract 9.80% , 4572 Kcal/ Kg gross energy and 3600 Kcal/ Kg metabolizable energy. HW processed in this manner may be a good source of energy, protein and has considerable amount of fat. (Ristic and Kormanjos, 1988).

Sohail and Bashir(2002) cooked raw hatchery waste with water at 2:1 ratio for 15 minutes and then oven dried at 65C and ground . Hatchery waste meal (HWM) thus prepared contained 32% crude protein, 16% ether extract,0.9% crude fiber,40%total ash,11.4 %nitrogen free extract , 20% calcium and 0.6% available phosphorus with no E.coli and Salmonella. Hatchery by product contains 36.5% CP,28.5% EE,1.2% CF,27% ash ,18% Ca and 0.75% available P and 2850 kcal ME,(AL-Harathi et al,2010).

2.7 Utilization of Hatchery Waste in Poultry Feed

Saima (2001) found that total weight gains of birds fed various experimental diets(HW), (2, 4, 6%), the highest weight gain was observed in birds fed diets containing 4% toasted HWM(1539.38 g), while lowest in those fed diets with 6% level of cooked HWM.

Shahriar, et al (2008) found that body weight and feed intake of broilers in different period was significantly affected by HW Supplementation.

Sathishkumar, et al (2008) determined that Japanese quail hatchery waste was processed by cooking and drying. Processed Japanese Quail hatchery waste was analyzed for its proximate and chemical composition. A biological experiment was also carried out to study the use fullness of PJQHW as a feed ingredient in Japanese quail breeder ration , replacing fish meal. Incorporation of PJQHW in Japanese quail breeder ration in place of fish meal at different levels did not also influence daily mean feed consumption and feed efficiency per dozen eggs or per Kg egg mass .

Saima(2001) found that average weight gain of 28 day old birds fed control diets containing 2,4, and 6% toasted HWM and 2,4, and 6% cooked HWM

were 908.78, 859.25, 917.32, 878.23, 832.58, 849.67 and 711.55 grams respectively. Maximum weight gain was recorded in birds fed 4% toasted HWM (917.32). Minimum (711.55g) weight gain was observed in birds fed cooked HWM at 6% level. However, the average total weight gains of birds (0-42 days) fed various experimental diets were observed in birds fed diets containing 4% toasted HWM (1539.38 g), while lowest in those fed diets with 6% cooked HWM.

Saima (2001), also found that the highest feed consumption was recorded in birds (0-28 days) consuming diets with 4% of cooked HWM and the minimum feed consumption was recorded in birds fed on control diets.

Aparana and Patterson (1997) fed broilers with 2.5 and 5% extruded HW meal and found that feed intake and feed efficiency were comparable to corn soybean based diets.

In biological evaluation trial, no significant difference was observed among rations in which HWM replaced the fish meal at 0, 25, 50 and 75 levels in broiler rations. These rations showed that protein efficiency ratios were 1.68, 1.79, 1.65 and 1.64; apparent protein digestibility 66.17, 69.97, 64.06 and

62.01” net protein utilization 39.86, 41.58 ,38.10 and 36.12% biological value 59.96, 60.25,59.75 and 58.32” respectively ,indicating better balance of amino acid in HWM to be replaced with fish meal} . In six weeks performance trial , the body weight gains were 1807.69,1916.39 ,1788.39 and 1635.66gm in the four rations ,respectively , whereas , FCR values were 2.59, 2.32, 2.43 and 2.63 in the corresponding groups , which shows no significant difference among all rations (Sohail and Bashir,2002),

Mehdipour , et al (2009) showed that there was no significant difference in body weight of broilers for the starter and grower and the total period between different diets Broiler fed with 4.5 HW had higher feed intake than broiler fed 3% HW and control group In total period feed intake in broiler fed 4.5% HW was significantly higher than the control and 3% hatchery waste groups in the starter period there were no significant difference in feed conversion ratio among experimental treatments . On the grower and overall period highest feed conversion was observed in birds fed 4% HW.

Babkir et al (1991) found that replacement of super concentrate premix protein with air dried incubator reject eggs protein up to 50% had no significant effect

on the final weight in comparison with the control .On the other hand, birds fed diets containing air dried incubator reject eggs protein replaced 75% of the broiler super concentrate had the least food intake .Substitution of broiler super concentrate with air dried incubator reject eggs proteins had no significant effect on feed conversion efficiency ,slight reduction in feed conversion efficiency was noticed at 75% level of replacement . the above mention author reported that slaughter weight was significantly lighter in group C where air dried incubator reject eggs protein replaced 75% of the super concentrate premix protein. (Babkir, et al, 1991). Ismail and Ali (2011) evaluated the effects_of feeding different dietary levels of hatchery wastes (HW) on performance, tibia ash and blood calcium and phosphorus concentration in broiler chickens. Birds were fed corn-soybean meal diet for 7 days, the experimental treatments included 3 dietary treatments containing 1.5, 3 and 4.5 percent HW, in addition to the control without hatchery wastes, and they found that there were no significant differences between weight gains in different dietary treatments. Feed intake in chicks fed 4.5% HW was significantly higher and those fed 3% had lower feed intake. Feed conversion in 4.5%HW

treatment was significantly inferior compared to other treatments. Results of carcass analysis showed no significant differences between treatments. Laying hens during 25-41 wk of age was investigated by (AL-Harhi et al, 2010) who reported that HW could be fed to laying hens up to 10% without adverse effect on egg production traits , quality of fresh and stored eggs .

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental site and duration

The experiment was conducted at Atabra Veterinary Laboratory and Poultry farm at River Nile state between 9 March to 28 April 2011 during which the average temperature ranged between (33-40°C)

3.2 Experimental house

The experiment was conducted in an open sided deep litter poultry house (2.5m) height with corrugated iron sheets roofing, wire netting sides and concrete floor. The long axis of the house extended East West facing the direction of wind for efficient natural ventilation. The house was partitioned into sixteen experimental pens of equal size (1x1 meter) area, with enough working space. The dividing partitions were made of wire netting walls. Twenty four hours continuous light was provided until the end of experiment. The experimental house and equipments were thoroughly cleaned and disinfected a week before the arrival of the experimental birds .Fresh sand was spread as litter in the pens at a depth of 5cm, and each pen was provided with

one tubular feeder and one fountain drinker. Feed and water were provided for ad libitum .

3.3 Experimental birds

Three hundred day-old commercial unsexed broiler chicks (Hubbard F15) were purchased from the Arabian Poultry Breeders Co. (Ommat) in Khartoum. They were transferred to Atabra, and soon after arrival they were unpacked located on to the deep litter experimental pen. First they were received a dose of multivitamins and sugar in drinking water to help reduce transportation stress. Birds were visually inspected for health and vigor, and weak unthrifty and under – weight chicks were excluded. One hundred and sixty experimental birds were then selected from the remaining birds, considering uniformity. The birds were randomly divided into four treatments group of 40 birds each treatment which further divided into 4 replicates (10 birds/replicate) . The birds were vaccinated against Infectious Bronchitis (IB) and Newcastle at 7 days old, Gumboro at 14 day and Newcastle at 28 day.

3.4 Experimental diets:

3.4.1 Hatchery Waste (HW) Preparation.

Raw HW (Empty shells, infertile eggs, dead embryos, late hatchings and dead chicks) was procured from Arabian Poultry Breeder Co. (Ommat) Hatcheries (Khartoum state) . Soon after collection HW was homogenized and raw HW was then toasted in an open vessel on gas fire at 100 C without addition of

water, ground by hand meat machine process, and then dried in an oven at 160C for 2 hours . The dried product was subjected to Microbiological (Tests for Salmonella and E.coli) as well as proximate chemical analysis according to the methods outlined by AOAC. Dried meal was then milling by hand mill for further use.

3.4.2 Diets formulation

Four diets were formulated to meet the nutrients requirement recommended by the National Research Council (NRC 1994) for broiler chicks. The dietary treatments included, diet1 (TA) diet without HW which served as control diet, then HW was incorporated the diets at .3, 6 and 9% to give diet 2 (TB), diet 3 (TC) and diet 4(TD) , regarding that all diets were iso caloric iso nitrogenous (Table, 2).

Table (1) Hatchery waste chemical composition

Nutrient	%
Dry matter	98.6
Crude protein	21.87
Crude fiber	1.4
Ether extract	8.6
Ash	3
Ca	24
P	1.25
ME(MJ/Kg)*	15.5

*ME: value was calculated according to the equation of Lodhi et al (1976).

Table (2) Composition and Calculated Analysis of the Experimental Diets

Ingredients	Hatchery Waste Inclusion %			
	0.0	3	6	9
Sorghum	63.247	59.455	56.237	51.8
Ground nut cake	28	31.5	33	36.29
Concentrate	5	2.5	2	0
Hatchery waste	0	3	6	9
DCP	1.16	1.28	1.11	1.5
Lime stone	0.9	0	0	0
L.Lysine	0.143	0.36	0.385	0,507
DL.Methaionine	0.07	0.145	0.168	0,203
Veg.Oil	1.28	1.56	0.9	0.5
Salt	0.1	0.1	0.1	0.1
Mycotoxin	0.1	0.1	0.1	0.1
Total	100	100	100	100
Calculated analysis				
Crude protein (CP %)	23.36	23.11	24	24.5
Crude fiber (CF %)	3.98	4.16	4.24	4.68
Lysine %	1.2	1.2	1.2	1.5
Methaionine %	0.51	0.5	0.5	0.6
Calcium %	1.1	1.2	1.5	2.6
Av.phosphrus %	0.45	0.45	0.45	0.41
ME(MJ/Kg)	13.39	13.39	13.39	13.14

3.2 The field trial

Throughout the experimental period the birds, house equipment, health, lighting, watering, feeding and other similar management activities were under observation and control. Any abnormal signs were observed, corrected, and recorded. Performance data was collected on weekly basis throughout the experimental period which included

3.2.1 Live Body weight (LBW) (g/bird)

Body weight was measured for all bird at the beginning of the first week of the experiment, and then calculated weight weekly by the end of each week at the same time.

3.2.2 Body Weight gain (BWG) (g/ bird)

Weight gain was calculated by subtraction the live weight at the beginning of the week from live body weight at the end of the same week.

3.2.3 Feed intake (FI)

Feed intake is the amount of feed consumed every week; it was calculated for each replicate on weekly basis. At the end of the week the residual amount of feed was weighed and subtracted from the amount feed provided throughout

the week. The product was divided by the total number of bird given the average feed intake.

3.2.4 Feed Conversion Ratio (FCR) (g feed/g gain)

Feed conversion ratio (FCR) was calculated from the recorded FI and BWG, by using the following equation:

$$\text{Feed conversion ratio (FCR)} = \text{Feed consumed (g)} / \text{Weight gain (g)}$$

3.2.5 Mortality Rate (%)

Mortality was recorded when occurred for each replicate and mortality percent was calculated by using the following equation:

$$\text{Mortality (\%)} = \text{Total number of dead birds} / \text{Total number of birds} \times 100$$

3.2.6 Slaughtering

At the end of the 6th weeks, birds were weighed and starved overnight (except for water). The birds from each replicate were selected and slaughtered without stunning, then scalded, manually plucked, washed and allowed to drain on wooden table. Evisceration was performed by a ventral cut and visceral as well as thoracic organs were removed. Eviscerated carcasses were weighed and then chilled for 12 hours, cold carcasses weights were recorded. Four birds were

picked from each replicate (2male and 2 female), weighed and then slaughtered to find out the dressing percentage. Two carcasses were randomly selected from each replicate for carcass cuts (Breast, thigh and drum stick) relative weight.

3.3 Chemical Analysis

The determined chemical analysis of the HWM indicated that HWM had 3% ash, 8.6% ether extract, 21.87% CP, 1.4% CF, %, 24% Ca, 1.25 % P and 15.5MJ/Kg

3.4 Statistical analysis and experimental Design

A completely randomized design (CRD) was used in the experiment. Collected data were subjected to analysis of variance(ANOVA) according to the general linear model procedure of SPSS soft ware (SPSS, 2001).The significant differences among means were determined by least significant differences (L.S.D) tests(Steel et al., 1997).

Chapter four

4.0 Results

4.1. The effect of feeding graded levels of H.W on weekly feed intake (g/bird)

Weekly feed intake (g/bird) is presented in Table (5). The results showed that there were no significant differences in feed intake between dietary treatment means during the first and the second weeks. The birds fed on 9% H.W showed a significantly ($P<0.05$) low feed intake during the 3rd, 4th and 5th week.

4. 2 The effect of feeding graded levels of H.W on weekly body weight gain (g/bird).

The results of weekly mean weight gain (g/bird) are presented in table (6). The results showed that the birds fed the control diet (0.0% H.W) have significantly ($P<0.05$) higher weight gain during the first week compared to all other dietary treatment means. In the same week (wk1) the birds fed 9 % H.W gave significantly lower ($P<0.05$) in weight gain compared to all other dietary treatments (3.6% Hw). The 2nd week resulted in significant ($P<0.05$) reduction

in weight gain for birds fed 9% H.W compared to those birds fed the control diet 0.0, 3 and 6% H.W while no significant differences among birds fed the control diet 0.00% H.W, 3%H.W and 6% H.W The third week showed a significant ($P<0.05$) higher weight gain for birds fed 3% H.W compared to all other dietary treatments including the control (0.0% H.W).There were no significant differences in weight gain between birds fed the control diet 0.00% H.W and those birds fed 6% H.W during the 3rd week. The results of weight gain during the 4th and 5th weeks showed no significant differences among all dietary treatments.

4.3 The effect of feeding graded levels of H.W on carcass cuts and dressing percentage

In Table (6) The mean breast weight (g) resulted in significant ($p<0.05$) reduction for birds fed (0.0 and 9%) HW compared to those fed (3 and 6% HW). The result of mean thigh weight was similar to the result of the mean breast weight, while the mean drum stick weight showed no significant difference among all treatments.Dressing percentage (6%) was significantly ($P<0.05$) lower for carcasses of birds fed 9% H.W compared to other carcasses of birds fed other dietary treatments.

4.4 The effect of feeding graded levels of H.W on the performance during the whole period (1-6 wk).

The overall performance results are presented in Table (4). The mean feed intake (g/ bird) resulted in a significant ($p < 0.05$) reduction for birds fed 9% H.W compared to those fed other dietary treatments. The mean total weight gain (g/bird) followed the same trend. Final live body weight (g/bird) resulted in no significant differences between the birds fed the control diet (0.0% H.W) compared to those fed 3% H.W while both dietary treatments resulted in significant ($p < 0.05$) improvement in final live body weight (g/bird) compared to those birds fed 6 and 9% H.W. The birds fed 6% H.W have significantly ($p < 0.05$) higher final live weight (g/ bird) compared to those birds fed 9% H.W.

Feed conversion ratio by the birds fed on the control diet (0.0%), 3% H.W and 6% H.W was significantly ($P < 0.05$) improved compared to those birds fed 9% H.W.