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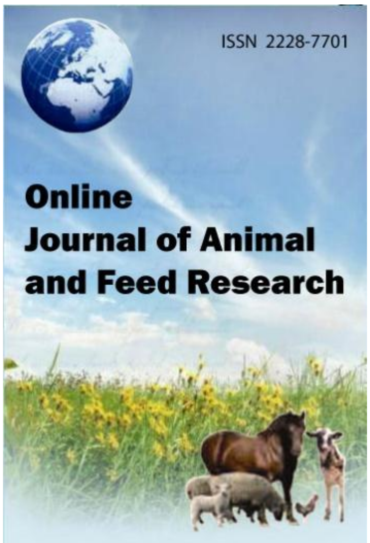

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EFFECTS OF WHOLE COTTON SEED SUPPLEMENTATION ON CARCASS AND MEAT QUALITIES OF THE DJALLONKE SHEEP RAISED ON STATION

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ORIGINAL ARTICLE

ABSTRACT: *This on-station study evaluated the effects of whole cotton seed supplementation on the carcass and meat qualities of Djallonke sheep. Twelve sheep of similar age and weight were randomly selected and supplemented with whole cotton seed (WCS) for fifteen weeks in a completely randomized design. Three treatment levels of 0 g, 200 g and 400 g were offered with four replicates. Supplementation had no adverse effect on carcass quality but significantly (P<0.001) improved juiciness and overall liking of the meat. The results suggest that whole cotton seed could be used as a supplementary feed with 200 g being enough to ensure the survival and to improve the productivity and meat quality of the Djallonke sheep.*

Keywords: Djallonke sheep, cotton seed, carcass

INTRODUCTION

In Northern Ghana, small ruminants can be found in almost every household in the communities. They feed on low quality food particularly, fibrous vegetation which cannot be consumed by humans and non-ruminant animals such as pigs and poultry (Ruth, 1991). They produce the bulk of meat for households (Salifu and Teye, 2006). However, dry-season feeding is difficult due to scarcity and /or poor quality of feed resources. Productivity of animals decrease as a result of scarce and or poor quality feed resources (Danso-Meriku, 2005). The natural vegetation which is the main feed resource is often completely burnt in the dry season and this result in virtually nothing for the animals to graze. Supplementary feeding is therefore a requirement for maintenance or higher turnover in livestock production.

The consumption of meat and its value depends on carcass and meat qualities. Components of carcass and meat qualities are yield and composition, appearance, eating quality, technological characteristics, palatability, wholesomeness and ethical quality (Warriss, 2001). The most important aspect of eating quality is the combined effects of tenderness, juiciness and flavour (Jones, 1995). Tenderness of meat tends to be higher when animals grow rapidly, particularly just before slaughter (Lauorngholz and Ballet, 1997).

Cotton seed is known for its high nutritive value, which includes 25% crude protein, 20.8% crude fibre, 17.5% ether extract, 16% calcium and 5% ash (Calhoun et al., 1995). It was estimated that about 22,200 – 24,220 metric tonnes of cotton seed is produced annually in Northern Ghana (Karbo and Bruce, 2000). An on-farm experiment with cotton seed supplementation indicated that eating qualities were positively affected (Kwarteng, 2009). It is against this background that this experiment was carried out on-station to validate the effect of whole cotton seed supplementation on carcass and meat qualities of the Djallonke sheep.

MATERIALS AND METHODS

Location and experimental design

The study was conducted on-station at the Nyankpala campus of the University for Development Studies. A total of twelve (12) Djallonke rams of similar age group and an average initial weight of 14 kg were randomly allocated to three (3) treatments with four (4) replicates. The supplemented groups were confined and fed with cotton seeds daily in the morning by 6:00 am before being released to join the other flock on the range. The treatment levels were as follows: Control: 0 gram whole cotton seed supplementation (WCS), T1:200 g WCS and T2:400 g WCS. The experiment lasted for fifteen weeks.

Slaughtering and Sampling

At the end of the feeding trial, the animals were taken to the University for Development Studies Meat Processing Laboratory. The final live weights of the animals were recorded before slaughtering. The animals were each stunned and bled by severing the carotid arteries in the jugular furrow close to the head. Singing was done by the use of firewood and knives to scrape off the hair on the skin. Evisceration was done immediately after singing and washing according to standard procedures.

Experimental parameters measured

Carcass and meat qualities evaluation: immediately after evisceration, the hot carcass weights were taken using a digital scale. The carcasses were then chilled overnight and cold carcass weights were taken 24 hours after slaughtering using the same scale. The weights of the primal cuts; the thigh, shoulder, and the *Longissimus dorsi* (LD) muscle were taken. The weights of empty rumen, intestine and other visceral were also taken.

Drip loss*:* Fifty grams of the left LD was hanged from a nylon thread in a transparent polythene bag, the ends of the bag fastened and hang in a refrigerator at +2 °C for a period of 72 hours. After which the weights were re-taken to determine the drip loss.

Fat (ether extract) extraction: crude fat content of samples was determined by the ether extraction method (AOAC 2003; method 991.36) using a Soxtec system (Foss, UK). Three grams of each sample was dried at 100 °C in an oven (J.P. Selecta, S.A) for three hours. The samples were then ground into fine powder with a ceramic laboratory mortar for the fat extraction.

Moisture determination: empty crucibles were initially weighed and approximately 3 g of each sample was put into the crucible and re-weighed. The weights of the samples plus crucibles were noted using a digital scale (Sartarious A.G. Gottingen, Germany) and noted "W_1". The samples plus the crucibles were put in an oven (J.P. Selecta, S.A) and the oven set at 105 °C for three (3) hours. The crucibles with the samples were put in a desiccator to cool. The samples plus crucibles were weighed using the same digital scale and was noted "W_2". Estimation of the moisture content was done using the formula "W_1-W_2"

Estimation of crude protein by digestion method*:* Weighed samples were put into digestion tubes. Two Kjeltabs were added to each tube and 15 ml of concentrated sulphuric acid was added to each tube and gently mixed to wet filter paper. The samples were then loaded onto the digestion block which was set at 420 °C for 30 minutes. All samples were distilled using automated/manual Kjeldahl distillation systems (Pro-Nitro II).The digested samples were placed into the Pro-Nitro II after the addition of 50 ml of 40% NaOH and distilled for nine (9) minutes. The distillates were collected into receiver solution (4% Boric Acid) and the crude protein estimated.

Sensory analysis

Eating quality was assessed by a fifteen (15) taste panellist who evaluated the intensity of these characteristics: tenderness, juiciness, colour and flavour. The LD musle was thawed at room temperature. The thawed LD was sliced into five chops of 3.5 cm thickness and griddled to a core temperature of 70 °C (using turbofan blue sealed oven, UK). During the cooking period/ the chops were turned over every five minutes. Chops were then trimmed of all adhering fats. Three rectangular samples were cut from each chop, wrapped in pieces of labelled foil and presented to the assessors. Bread was used as a neutralizer alongside water. Assessors used a five-point category scale to evaluate sample: tenderness (1 very tender, 5 very tough), juiciness; (1 very juicy, 5 very dry), lamb flavour; (1 very strong, 5- very weak), and overall liking; (1 – like very much, 5 – dislike very much).

Statistical analysis

The data obtained was analysed using the general linear model of analysis of variance (ANOVA) of Minitab version 15.0 (Minitab, PA USA).

RESULTS AND DISCUSSION

Effect of whole cotton seed on live, warm and cold carcass, thigh, shoulder and *Longissimus dorsi* (LD) muscle weights

The effects of supplementation and non-supplementation of whole cotton seed on live, warm and cold carcass, thigh, shoulder and *Longissimus dorsi* (LD) muscle weights are present in Table 1. Live and warm carcass weights tended to be higher for T1 and T2 compared to the control group. The thigh and LD muscle tended to favour the control group.

However, supplementation did not have any significant effect (P>0.05) on live, warm and cold carcass weights for the various treatments (Table 1). Similarly, there was no significant difference (P>0.05) in weights among the various treatments for thigh, shoulder and LD muscle, a reflection of the non-significance live and carcass weights (Table1).

The insignificant differences observed in weights for warm and cold carcass, thigh, shoulder and *LD* muscle are an indication that whole cotton seed has no adverse effect on growth and development of the animal hence, similar carcass yields. This suggests that cotton seed has a potential for use as a supplement for sheep. This result is in agreement with a previous report that, there is a potential for increased carcass yield when sheep and goats are supplemented with cotton seed (Kwarteng, 2009).

Table1- Live weights, weights of warm and cold carcass, thigh, shoulder and LD muscle

Weights (kg)	Control	T1	T 2	SED*	P-value
Live	11.50	14.50	15.50	4.858	0.70
Warm carcass	7.83	8.34	8.75	2.860	0.96
Cold carcass	6.95	5.63	6.00	2.154	0.79
Thigh	0.59	0.55	0.54	0.220	0.97
Shoulder	0.36	0.37	0.36	0.147	0.99
LD Muscle	0.55	0.48	0.48	0.211	0.85

*Standard error of difference

Effect of whole cotton seed on crude protein, ether extract, percentage moisture and drip loss in the *Longissimus dorsi* (LD)

There was no significant difference (P > 0.05) observed for the various treatments on crude protein, ether extract, and percentage moisture (Table 2). However, drip loss was significantly (P<0.05) reduced in the supplemented groups. An indication that cotton seed supplementation did not have any adverse effect on crude protein level, ether extract and percentage moisture but improved moisture retention in the meat. Thus supplementation with whole cotton seed positively improved crude protein level and percentage moisture, and relatively reduced ether extracts and drip loss in the LD muscle.

There was relatively high moisture content in the supplemented groups than the control, and a corresponding less drip loss from the supplemented groups which might have contributed to its juiciness and tenderness of the LD muscle. Muscles with better water holding capacity have an advantage for further processing. Water holding capacity

(WHC) is the ability of meat to retain its water during application of external forces such as heating, cutting, mincing and processing (Boles, 2003).

Table- 2 Crude protein, ether extract, percentage moisture and drip loss of LD muscle

	Control	Trt 1	Trt 2	SED*	P-value
Crude protein (%)	50.31	53.51	53.45	4.421	0.70
Ether extract (%)	1.96	1.66	1.57	0.360	0.54
Moisture content (%)	53.40	57.38	57.31	5.242	0.67
Drip loss (mg)	3.5^{b}	2.2^{a}	2.5^{a}	0.480	0.05

*Standard error of difference; means in the same row with similar superscripts are not significantly different (P>0.05)

Eating qualities of *Longissimus dorsi* (LD) muscle

There were significant differences (P<0.001) between the various treatments for juiciness and overall liking (Table 3). There was also a significant difference (P≤0.05) in tenderness between the various treatments. There were no significant differences (P>0.05) in colour and flavour. *Longissimus dorsi* (LD) muscles from supplemented groups retained more moisture, making these muscles juicier, tender and likened more compared to the control. Lawrie (2006) reported that increase in water holding capacity improves tenderness of the flesh when cooked. Kwarteng (2009) also reported that there was no adverse effect on meat quality of small ruminants when supplemented with cotton seed and that a positive eating attributes of juiciness was as a result of the better water holding capacity induced as a result of cotton seed supplementation. Their reports are in agreement with our findings. Our study may also suggest that, most Ghanaians prefer meats that are moderately red, more tender and juicy, with high lamb flavour.

Table- 3 Eating qualities of the LD muscle

Attributes	Control	Trt 1	Trt 2	*Sed	P-value
Color	1.73	1.67	1.53	0.241	0.70
Tenderness	2.80^{a}	2.10^{b}	2.67^{ab}	0.310	0.05
Juiciness	3.20^{a}	1.70^{b}	2.40^{ab}	0.280	0.00
Lamb flavor	1.67	1.93	1.45	0.252	0.19
Overall liking	2.90^{a}	1.6^{b}	2.50^{ab}	0.243	0.00

*Standard error of difference; means in the same row with similar superscripts are not significantly different (P>0.05)

CONCLUSION

The result of this present study suggest that supplementation of whole cotton seed at a level of 200 g produced animals with the most favourable nutritional, and eating qualities of *Longissimus dorsi* (LD) muscles. In general feeding of whole cotton seed up to 400 g in the diets of sheep have no adverse effects on the meat quality. Therefore the readily available cheap feed (whole cotton seed) produce in excess in the Northern part of Ghana especially in can be stored and used to feed sheep during the dry season when animal feed is scare.

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POISONOUS PLANTS IN GARDENS AND GRAZING LANDS

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REVIEW ARTICLE

ABSTRACT: *This paper is a review of poisonous plants, their toxic agents and the symptoms of poisoning. Poisonous plants are plants, which as a whole or part thereof under all or certain conditions and in amount likely to be taken or into contact with an organism will exert harmful effects or causes death either immediately or by reason of cumulative action of toxic property due to presence of known or unknown chemical action. There are different types of diseases caused by some poisonous plants. Poisonous plants can reduce livestock productivity depending on the effect they have and the amount consumed. Since poisonous plants are potential threats to the livestock industry it is important that farmers are carefully to avoid contamination of rations prepared for livestock and removal of poisonous plants from grazing lands. Prevention and precautions are the best way to avoid any economic loss.*

Keywords: *Major genes, early lay traits, crossbred local chicken, humid tropics*

INTRODUCTION

Poisonous plants are plants, which as a whole or part thereof under all or certain conditions and in amount likely to be taken or into contact with an organism will exert harmful effects or causes death either immediately or by reason of cumulative action of toxic property due to presence of known or unknown chemical action. The poisonous nature of the whole plant or any plant part may be due to production of toxic substances such as alkaloids, glucosides, amines, toxalbumins, picrotoxins, resins, sponins, tannins etc., many of which are harmful to man and animal life (Katewa,et.al,2006).

Poisonous plants are found everywhere, in every continent and even in the deserts (Johnson, 2009). Poisonous plants have their uses for food, drugs, ornamentals and poison. Animals have adapted to survive the low doses of poisons or they do not eat the poisonous parts. There are poisonous plants that are too toxic for food and they have their uses as well. Goats and deer avoid oleander as well as foxglove and periwinkles. Plants such as yellow bells, frangipani, and poinsettias are all toxic and are used as ornamentals. Some poisonous plants are used as a source of poison for eradicating pests and rats. Poisonous plants can also be used for healing. Medicines have been created from plants at different dosages. Poisonous plants can heal as well as kill (Johnson, 2009).

Brown (2009) stated that "just because something is on the poisonous plants list doesn't mean it can't be a good food or feed, and just because it is absent from the list doesn't mean it is safe". A poisonous plant is one which, when consumed in such quantities as will be taken by animal or man over a short or prolonged periods, exerts harmful effects on the system or causes death by virtue of toxic substance(s) normally contained in the plant. There different types of poisoning by plants. Some good fodder plants may be poisonous for example grasses that produce hydrocyanic acid when in wilting stage, improper ingestion of some plants and dry grass full of cellulose can be converted into fibre balls in the gastro-intestinal tract and cause obstruction. Feeding livestock on grass deficient in minerals, proteins, lipids and vitamins cause some diseases. A plant may be poisonous to one animal species and non-poisonous to another. Some parts of a plant may be poisonous while other parts are harmless. There are different types of diseases caused by some poisonous plants. Photosensitization is caused by ingestion of photodynamic substance in the plant. This makes the animal hypersensitive to light such as *Tribulus terrestris, Lantana camara* and others. Table 1 shows some poisonous plants found in many parts of the world.

Table 1 - List of Scientific and Common Name Equivalents
A. muscaria: Fly Agaric
A. pantherina: Panther
A. verna: Destroying Angels
Abrus precatorius: Rosary Pea
Acer rubrum: Red maple, Swamp maple, Soft maple
Acer saccharinum: Silver maple, Soft maple, White maple
Acer saccharum: Sugar maple, Rock maple, Hard maple
Aconitum spp.: Monkshood, Aconite, or Wolfsbane
Actaea spp.: Baneberry, Dolls Eyes, White Cohosh, Snakeberry
Aesculus spp.: Horse Chestnut, Buckeye
Agrostemma githago: Corn Cockle
Aleurites fordii: Tung Oil Tree
Allium spp.: Commercial Onions, Wild Onions, Swamp Onions, and Chives
Amanita spp.: Monkey Agaric, Panther Cap, Death Cap, and Death Angel Mushrooms
Amaranthus spp.: Pigweed
Amsinckia intermedia: Fiddleneck
Apocynum spp.: Dogbane
Argemone mexicana: Prickly Poppy or Mexican Poppy
Arisaema spp.: Jack in the Pulpit
Asclepias spp.: Milkweed
Astragalus and Oxytropis spp.: Locoweed
Atropa belladonna: Belladonna or Deadly Nightshade
Brassica spp, : Rape, Cabbage, Turnips, Broccoli, Mustard
Caltha palustris: Marsh Marigold or Cowslip
Cannabis sativa: Marijuana
Centaurea solstitialis: Yellow Star Thistle
Chelidonium majus: Celandine
Chenopodium album: Lambs Quarters
Cicuta spp.: Water Hemlock or Cowbane
Claviceps spp.: Ergot
Conium maculatum: Poison Hemlock
Convallaria majalis: Lily of the Valley
Coronilla varia: Crown Vetch
Daphne spp.: Daphne
Datura spp.: Jimsonweed, Downy Thornapple, Devils Trumpet, Angels Trumpet
Delphinium spp.: Delphiniums and Larkspurs
Dicentra spp.: Bleeding Heart, Squirrel Corn, Dutchmans Breeches
Digitalis purpurea: Foxglove
Equisetum arvense and other spp.: Horsetail
Eupatorium rugosum: White Snakeroot
Euphorbia spp.: Poinsettia, Spurges, Snow on the Mountain
Fagoypyrum esculentum: Buckwheat
Festuca arundinacea: Tall Fescue
Gelsemium sempervirens: Jessamine
Glechoma spp.: Ground Ivy, Creeping Charlie, and Gill over the Ground
Halogeton glomeratus: Halogeton
Helleborus niger: Christmas Rose
Hyoscyanamus niger: Henbane
Hypericum perforatum: St. Johns Wort, Klamath Weed
Iris spp.: Irises
Laburnum anagyroides: Golden Chain or Laburnum
Lantana camara: Lantana, Red Sage, Yellow Sage, or West Indian Lantana
Lathyrus spp.: Sweet Pea, Tangier Pea, Everlasting Pea, Caley Pea and Singletary Pea
Leucothoe axillaris and Leucothoe davisiae: Drooping Leucothoe and Sierra Laurel
Linum usitatissimum: Flax
Lobelia spp.: Great Lobelia, Cardinal Flower, and Indian Tobacco
Lotus corniculatus: Birdsfoot Trefoil
Lupinus spp.: Lupine
Medicago sativa: Alfalfa or Lucerne
Menispermum canadense: Moonseed
Metilotus alba and Melilotus officinalis: White and Yellow Sweetclover
Nerium oleander: Oleander
Nicotiana spp.: Tobacco and Tree Tobacco
Onoclea sensibilis: Sensitive Fern
Ornithogalum umbellatum: Star of Bethlehem
Papaver spp.: Various Poppies including Opium Poppy
Phytolacca americana: Pokeweed
Pieris japonica and other spp.: Japanese Pieris, Mountain Fetterbrush
Pinus ponderosa: Ponderosa Pine
Podophyllum peltatum: Mayapple and Mandrake
Prunus spp.: Wild Cherries, Black Cherry, Bitter Cherry, Choke Cherry, Pin Cherry
Pteridium aquilinium: Bracken Fern
Quercus spp.: Oak Trees
Ranunculus spp.: Buttercups or Crowfoot
Rheum rhaponticum: Rhubarb
Ricinus communis: Castor Bean
Robinia pseudoacacia: Black Locust
Rumex spp.: Dock
Sambucus canadensis: Elderberry
Sanquinaria canadensis: Bloodroot
Saponaria spp.: Bouncing Bet and Cow Cockle
Senecio spp.: Senecio, Groundsels, and Ragworts
Solanum spp.: Common Nightshade, Black Nightshade, Horse Nettle, Buffalo Bur, Potato
Sorghum spp.: Sorghum or Milo, Sudan Grass, and Johnson Grass
Symplocarpus foetidus: Eastern Skunk Cabbage
Taxus cuspidata: Yew
Tetradymia spp.: Horsebrush
Toxicodendron diversiloba: Poison oak
Toxicodendron radicans: Poison ivy
Toxicodendron vernix: Poison Sumac
Trifolium spp.: Alsike Clover, Red Clover, White Clover
Triglochin maritima: Arrowgrass
Urtica spp.: Stinging Nettle
Veratrum californicum: Corn Lily, False Hellbore
Vicia spp.: Common Vetch, Hairy Vetch, Narrow leaved Vetch, Purple Vetch and Broad Beans
Wisteria spp.: Wisteria
Xanthium strumarium: Cocklebur
Zigadenus spp.: Death Camas
Source: Brown, 2011.

Table 2 - Some poisonous plants and their symptoms in poisoned animals.

PLANT	TOXIC PART	SYMPTOMS
HOUSE PLANTS		
Hyacinth, Narcissus, Daffodil	Bulbs	Nausea, vomiting, diarrhea. May be fatal.
Oleander	Leaves, branches	Extremely poisonous. Affects the heart, produces severe digestive upset and has caused death.
Dieffenbachia (Dumb Cane), Elephant Ear	All parts	Intense burning and irritation of the mouth and tongue. Death can occur if base of the tongue swells enough to block the air passage of the throat.
Rosary Pea, Castor Bean	Seeds	Fatal. A single Rosary Pea seed has caused death. One or two Castor Bean seeds are near the lethal dose for adults.
FLOWER GARDEN PLANTS		
Larkspur	Young plant, seeds	Digestive upset, nervous excitement, depression. May be fatal.
Monkshood	Fleshy roots	Digestive upset and nervous excitement.
Autumn Crocus, Star of Bethlehem	Bulbs	Vomiting and nervous excitement.
Lily-of-the-Valley	Leaves, flowers	Irregular heart beat and pulse, usually accompanied by digestive upset and mental confusion.
Iris	Underground stems	Severe-but not usually serious-digestive upset.
Foxglove	Leaves	Large amounts cause dangerously irregular heartbeat and pulse, usually digestive upset and mental confusion. May be fatal.
Bleeding Heart	Foliage, roots	May be poisonous in large amounts. Has proved fatal to cattle.
VEGETABLE GARDEN PLANTS		
Rhubarb	Leaf blade	Fatal. Large amounts of raw or cooked leaves can cause convulsions, coma, followed rapidly by death.
ORNAMENTAL PLANTS		
Daphne	Berries	Fatal. A few berries can kill a child.
Wisteria	Seeds, pods	Mild to severe digestive upset. Many children are poisoned by this plant.
Golden Chain	Bean-like capsules in which the seeds are suspended	Severe poisoning. Excitement, staggering, convulsions and coma. May be fatal.
Laurels, Rhododendrons, Azaleas	All parts	Fatal. Produces nausea and vomiting, depression, difficult breathing, prostration and coma.
Jasmine	Berries	Fatal. Digestive disturbance and nervous symptoms.
Lantana Camara (Red Sage)	Green berries	Fatal. Affects lungs, kidneys, heart and nervous system. Grows in the southern U.S. And in moderate climates.
Yew	Berries, foliage	Fatal. Foliage more toxic than berries. Death is usually sudden without warning symptoms.
TREES AND SHRUBS		
Wild and cultivated cherries	Twigs, foliage	Fatal. Contains a compound that releases cyanide when eaten. Gasping, excitement and prostration are common symptoms.
Oaks	Foliage, acorns	Affects kidneys gradually. Symptoms appear only after several days or weeks. Takes a large amount for poisoning.
Elderberry	All parts, especially roots	Children have been poisoned by using pieces of the pithy stems for blowguns. Nausea and digestive upset.
Black Locust	Bark, sprouts, foliage	Children have suffered nausea, weakness and depression after chewing the bark and seeds.
PLANTS IN WOODED AREAS		
Jack-in-the-Pulpit	All parts, especially roots	Like Dumb Cane, contains small needle-like crystals of calcium oxalate that cause intense irritation and burning of the mouth and tongue.
Moonseed	Berries	Blue, purple color, resembling wild grapes. May be fatal.
May apple	Apple, foliage, roots	Contains at least 16 active toxic principles, primarily in the roots. Children often eat the apple with no ill effects, but several apples may cause diarrhea.
Mistletoe	Berries	Fatal. Both children and adults have died from eating the berries.
PLANTS IN SWAMP OR MOIST AREAS		
Water Hemlock	All parts	Fatal. Violent and painful convulsions. A number of people have died from hemlock.
PLANTS IN FIELDS		
Buttercups	All parts	Irritant juices may severely injure the digestive system.
Nightshade	All parts, especially the unripened berry	Fatal. Intense digestive disturbance and nervous symptoms.
Poison Hemlock	All parts	Fatal. Resembles a large wild carrot.
Jimson Weed (Thorn Apple)	All parts	Abnormal thirst, distorted sight, delirium, incoherence and coma. Common cause of poisoning. Has proved fatal.

Source: Texas AgriLife Extension Service, Texas A&M System.

Table 2 shows some diseases caused by poisonous plants to animals and humans. Laminitis is caused by ingestion of *Crotolaria burkeana* by grazing ruminants. Prussic acid poisoning is one of the common forms of plant poisoning. The glucosides in the plant break up producing prussic acid which is highly toxic to animals. Treatment involves moving the animals away to a different part of the grazing lands where the animals cannot access such plants. Treatment is not always successful, prevention is the best approach. Table 3 shows the different types of toxic agents in poisonous plants.

Table 3,a - Toxic agents in poisonous plants

ALKALOIDS Indole Alkaloids (Beta-carbolines etc.) Indolizidine Piperidine Polycyclic Diterpene Pyridine Pyrrolizidine Quinolizidine Steroids Tropane Tryptamine ALCOHOLS AND KETONES Alcohols Diacetone alcohol Diethylene glycol Ethanol Ethylene glycol Methanol Propylene glycol Ketones Cicutoxin Tremetone Treratol	LIPIDS Fatty Acids Cyclopropenoid fatty acids Erucic acid Fluoroacetate Glycolipids METALS Heavy Metals Copper Mercury Selenium Arsenic Lead Iron
CARBOHYDRATES Oligosaccharides Beta-glucans Pectins Raffinose Simple Sugars Favism Fructose Galactose Lactose Sucrose Xylose	MYCOTOXINS Aflatoxins Citrinin Fungal Tremorgens Lupinosis Ochratoxins Patulin Rubratoxins Sporidesmin Stachybotyrotoxins Trichothecenes Zearalenone

Table 3, b - Toxic agents in poisonous plants

CHELATING POISONS Nitrates Nitrites Oxalates Phytates	PHENOLIC TOXICANTS Cinnamic Acid Fagopyricin Gossypol Hypericin Pterocin Resoricinol Urushiol Tannins
GLYCOSIDES Calcinogenic Glycosides Carboxyatractylosides Cardiac Glycosides Coumarins Furocormarins Glucosinolates (Goitrogenic Glycosides) Isoflavones and Coumestans Nitroglycosides (Nitropropanol Glycosides) Ranoculins Saponins Vicine/Covicine	PROTEINS AND AMINO ACIDS Allergens Amylase Inhibitors Enzymes Lipoxidases Thiaminases Tocopheroloxidase Lectins Abris Concanavalin Ricin Robin Plant Cytoplasmic Proteins Polypeptides Amino Acids
VITAMINS Vitamin A Vitamin D metabolites MISCELLANEOUS Ipomemaron - mycotoxin? Alsike Poisoning - mycotoxin? Red Maple Poisoning (similar to Brassica induced anemia) Plant Carcinogens n-Propyl Disulfide (similar to Brassica induced anemia)	Nutrient Leucine Methionine SMCO Tryptophan Non-nutrient Arginine analogs Canavanine Indospecine l amino D proline dihydroxyphenylalanine Lathyrogens Mimosine RESINS SESQUITERPENE LACTONES

Source: Brown, 2009.

Some common poisonous plants in Botswana

An Act to provide for the eradication and destruction of noxious weeds commenced in 1916 in Botswana and it is cited as Noxious Weeds Act (Government of Botswana,1916). The Act made provision for the destruction of poisonous plants such as burweed (*Xanthium spinosum*).

Xanthiums spp

The common name is Cocklebur belonging to family composite with a local name of "Motlhabakolobe "or "Khonkhorose". The genus Xanthium has four species in Southern Africa and all have characteristic burs. Burs are the fruits, which develop from composite flowers on the leaf axis. The four commonest species in Botswana are *Xanthium accdentale* L., *Xanthium pungens* Wall, *Xanthium spinosum* L., *and Xanthium strumarium* L.

The bur causes mechanical injury to cattle, sheep and goats. The bur may cause partial and even complete obstruction of the orifice of the sheath in bulls or oxen grazing on lands overgrown with *Xanthium* weed. The most susceptible animal to Xanthium poisoning is the pig, and great numbers may be lost through eating the plant at the cotyledon stage, namely the seedling with two leaves. The symptoms of poisoning by Xanthium include depression; nausea accompanied by vomiting; weakness; unsteady gait; twisting of neck muscles; rapid and weak pulse and low body temperature.

Poisoning by *Xanthium* arises from the ingestion of the immature plant and not the bur. During this cotyledon stage, the first leaves are dependent on the bur for energy, and it would appear that the toxic principle is in the seeds which are then transferred to the pair of temporary leaves. The toxic compounds that have been isolated in Xanthium are the glucoside xanthostrumarin and choline.

Like most toxic and undesirable species, *Xanthium* will invade disturbed areas around boreholes, farmsteads, villages, kraals, cultivated fields etc. It is a poisonous annual plant, which indicates misuse of the land. The burs stick to the animal and can be carried long distances. This way, the seeds get easily dispersed. *Xanthium* plants should be destroyed before the development of the seeds. On cultivated fields the soil should be ploughed before the plant matures. On rangelands, it is worth the effort to make sure that the *Xanthium* plants are grubbed before flowering.

Argemone Mexicana

Argemone Mexicana of local names either sekgarakgara or lopero is an herb of up to 60 cm tall. Stem spiny, bluesh green with a sticky yellowish latex. Leaves simple, alternate, deeply looped. Its seed and stem are poisonous when eaten in large quantities especially in early springs, in the tropics *Argemone Mexicana* flowers and fruits throughout the year. The flowers open early in the morning and last for two to three days. In most cases it pollinates itself though small bees usually do.

A. Mexicana is poisonous to both human and domestic animals (Sharma et al., 1999). It is common in disturbed areas throughout the country of Botswana, hence it is very important that it is identified and know and even studied as it pose an economical threat to the farming world. Cattle do not graze the plant as it is spiny but they can be poisoned if they consume it in hay or the chuff, sheep and goats can eat it when the vegetation is short of supply, while ostrich relish it.

The alkaloids sanguinare and dihydrosangunairine found in the seed and the rots are the primary toxins. The physiological active iso quinoline alkaloids berberine, protopine, coptisine, allocryptopine and dehydrochelcrythrine are found in all plants parts. According to Sharma et al., (1999) the total alkaloids toxicity has been tested on rats and mouce, the results extrapolated to man would indicate a lethal alkaloid dose for a 100kg (220 lb) would be 0,1g.as a result of testing on monkeys it has been recommended that maximum allowed contamination of oil should be less than 0, 01%.

Livestock has been poisoned by inclusion of this poisonous plant in hay but the more common route of intoxication is when the seed is being included as contaminant of other grains. Experimentally sangunarine alone fail to induce symptoms produced by oil, oil produced by pressing the seed is highly toxic (vearrier, 2009). A toxic amount of the alkaloid or its degradation products may be transmitted in the milk of animals not showing toxic symptoms. The yellow sap is slightly corrosive and produces dermatitis in sensitive individual. The prickly leaves and folds produce minor mechanical injuries to the mouths and skin of livestock.

Gastro-intestinal tract irritation is common, and toxic ingestions almost invariably result in emesis. Onset of symptoms is rapid. GI upset and vomiting start 45 minutes to 4 hours after ingestion. CNS effects include drowsiness, weakness, loss of coordination, muscle fasciculation, seizures.

In humans and chickens, widespread edema (dropsy) is the main finding. Chickens exhibit a swelling of the wattles and darkening of the tips of the comb and also a decrease in egg production, weakness, hemorrhagic enteritis and death.

Affected animals will show:

- Severe jaundice and photosensitization in the form of severe dermatitis on the light colored areas of the skin.
- Death from hemorrhagic gastroenteritis may occur if animals consume it in large quantities.

Sanguinarice has been shown to possess pro-oxidant property in invitro towards the production of free radicals including singlet oxygen and hydrogen peroxide. Prior invitro status have shown that reactive oxygen spices are involved in induced toxicity causing peroxidative damage of lipids in various hepatic sub cellular fraction including microsomes and mitochondria. In acute cases intra venous injection of a sodium thiosalfate and sodium nitrate can bring dramatic change

Dichapetalum cymosum

This is one of the most important poisonous plants in Botswana with local name "mogau". *Dichapetalum cymosum* (common name *gifblaar* or occasionally the English translation, poison leaf) is a small dwarf shrub occurring mostly in the Western parts of Botswana i.e Tsabong, Ghanzi. The poison leaf plant or mogau as widely known in the local communities has since been spread to many other parts of the country like Maun, Kgatleng and Kweneng even though it is not heavily populated. It is notable as a common cause of lethal cattle poisoning in these areas and is considered to be among the most toxic plants in Botswana. The chemical monofluoroacetate occurs in all parts of the plant and is responsible for the toxic effect. The monofluoroacetate affects the heart and nervous system reported by (Kellerman and Naude, 1996)

According to (Balinsky *and* Scheiderman, 1964) above the ground the plant is seen as a clump of small, woody shrub of about 15cm high. Such a clump is typically 1 plant as *gifblaar* has a huge underground root system – likened to an underground tree- and sends numerous shoots above ground in favourable conditions. The most obvious above ground parts are the leaves – simple, alternative with initially fine hairs later becoming glabrous. The leaves are bright green in colour in both sides. The secondary veins forms loops and do not reach the margins. Flowers are small, white and occur as dense clumps in the early spring. Fruit formations are rare; the fruit are orange and leathery.

Identification of *Dichapetalum cymosum* in the rangelands is important in prevention of toxicity and also in assigning it as a cause of toxicity in an outbreak. It is a small, low-growing, non-descriptive shrub and thus easily confused with other species. There are four principal "confusers" in its habitat. These are Ochna pulchra saplings, Parinari capensis, Pygmaeothamnus spp and the various genera and species of the family Rubiaceace. *Dichapetalum cymosum* occurs in dry, sandy areas in acidic soils, as well as the northern slopes of rocky hills in the southern parts of Africa. In Botswana it is widely distributed in the western veld with few plants other areas across the country. *Dichapetalum cymosum* also occurs in Namibia, South Africa, Zimbabwe as well as southern Angola.

The toxic compound isolated as the cause of *Dichapetalum cymosum* poisoning is monofluoroacetate. It was first isolated by Marais, (1943); the LD50 of this compound is 0,5mg\kg which translates to about 200g of dry plant material to kill a 500kg cow. The compound in itself is not toxic. However, it undergoes lethal synthesis in the body reacting with Coenymes A to make Fluoroacetyl-Coenymes A. This compound reacts with oxaloacetate to form fluorocitate, which is toxic; being an alternate substrate for aconitase (normal substrate citrate.) it binds to the aconitase but cannot be released, irreversibly binding the aconitase. This causes the Krebs cycle to shut down, leading to massive energy shortages. Furthermore, fluorocitrate stops citrate from crossing from the cytoplasm into the mitochondrion, where it is needed. In the cytoplasm it gets degraded.

Louw et al., (1970) reported that in cattle, acute death by cardiac arrest is seen following drinking or some kind of exertion. Affected animals will show dyspnoea and arrhythmias prior to this. There may occasionally be nervous signs such as trembling, twitching and convulsions. Death occurs 4 – 24hours after ingestion. In rare cases, an animal will survive the initial period only to drop dead months later of a heart failure – so called chronic *Dichapetalum cymosum* poisoning. On post-mortem, leaves may be found in the rumen, cyanosis may be seen, as well as signs of heart failure – congestion, haemorrhage, and myocardial necrosis (on histopathology.) diagnosis is based on these as well as the presence of *Dichapetalum cymosum* in the camp, particularly if signs of consumption are seen. Laboratory tests can be done for monofluoroacetate in the rumen fluid, kidneys and the liver.

Treatment

- It is thought withholding water for 48hours can help.
- Ensure animals remain calm and rested.
- Remove the animals from the infected rangelands, but without exciting them.

Grobbelaar and Mario-Meyer, (1990) reported that cattle are mostly affected; with sheep, goats and game rarely being poisoned even though compound is equally poisonous to these species. An explanation is that the bulk grazing style of cattle, which is by nature less selective lends itself to the ingestion of the plant. Young sprouts have more monofluoroacetate, but all parts are lethal. The plants sprouts in late winter, before the spring rains, the cue for most plants – including grasses – to shoot. This makes it the predominant greenery during that period. Cases of poisoning are most frequent during that period. Later in the season, *Dichapetalum cymosum* poisoning is far less common, presumably enough other grazing occurs that *Dichapetalum cymosum* is not eaten. Autumn (late season) poisoning also occurs. Poisoning of carnivores, including dogs, has been reported after consumption of ruminal contents of poisoned animal stated by (Marais, 1944). Caution should be taken and animals should only be grazed later in the season, and the camps or rangelands should not be overgrazed.

CONCLUSION

Poisonous plants can reduce livestock productivity depending on the effect they have and the amount taken. Since poisonous plants are potential threats to the livestock industry it is important that farmers are carefully to avoid contamination of rations prepared for livestock and removal of poisonous plants from grazing lands. Prevention and precautions are the best way to avoid any economic loss.

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IMPACT OF MATERNAL EGG SIZE AND RESTRICTED FEEDING REGIME ON SOME GROWTH CHARACTERIZES OF BROILERS REARED UNDER HUMID TROPICAL ENVIRONMENT

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ORIGINAL ARTICLE

ABSTRACT: *The experiment was conducted to investigate the effect of different egg size from which birds are hatched have on their performance in terms of their growth traits and also to examine the effect of feeding regimen on the performance of Anak Titan broilers in a CRD study. The feeding regimes were ad- libitum (AL) and restricted feeding.(RF) The growth traits measured were feed intake (FI) body weight (BW), thigh length (TL), shank length (SL), breast length (BL) and body girth (BG) fortnightly. Efficiency of production was also evaluated using weight gain, feed conversion ratio, and mortality. Result showed that the egg size may affect the growth traits in that birds in group C (63-68g) with higher initial weight out performed that of B (58-62g) and A (50-57g), in terms of final body weight and most of the other growth parameters studied although there were no significant difference (P<0.05) between these three groups.. Body weights at 9th week for birds in A, B and C groups were 1386.59g, 1426.50g and 1521.05g respectively. The feeding regimes employed significantly (p<0.05) affected the performance of the broilers of combined egg size with the ad-libitum group being significantly (p<0.05) higher in values than birds on the restricted feeding group. There was no significant difference (P>0.05) in the interaction between birds of different egg size and feeding regimes. There was a high significant (p<0.05) correlation between body weight and all other growth traits throughout the study period. It is recommended that birds with egg weight range of 63-68g with high initial body weight and subsequent high performance under ad-libitum feeding should be adopted with occasioned restricted feeding to prevent wastage.*

Keywords: *egg size, feeding regimes, growth traits, broiler, humid tropics*

INTRODUCTION

According to Adeyinka et al. (2000), egg size is known to have a positive effect on growth and subsequent weight of domestic fowls. Walleman (1997) reported that the mean egg weight represent one of the most important factors governing the profitability of a laying enterprise, even small increase in egg weight can have significant effect on grading and hence economic returns. Thus, in the fowls, egg weight has been reported to determine the early growth of the chicks it produces.

Growth functions have been used extensively to represent changes in size with age, so that the genetic potential of animals for growth can be evaluated and nutritionally matched to possible growth (Lopez et al., 2000). Broiler production is totally dependent upon growth rate, market weight and total feed consumption. In order to achieve efficient poultry production and maximize profit, it is important to bring to the knowledge of the farmers the appropriate weight of broiler chicken at day-old hatched from a reasonable egg size that will give the required market weight at 8-10 weeks of age, under required quantity of feeding regimes and proper management.

New development in management techniques is driven by the demand to improve the efficiency of broiler production. Primarily, breeders incorporates these broiler production goals like feed efficiency, low body fat and high breast meat yield into their selection programmes and feed formulation techniques to express fully the genetic potential of their stock (Middle Koop, 1997). According to Olomu (1995), for breeder stock, especially broiler breeder stock, some form of feed restriction is usually recommended. The most common management techniques consist of restricting the amount of feed per day. The practical application of this varies from limiting the period when broilers can eat to supplying limited amount of feed per day (Ramlah et al., 1996, Olomu, 1995, Casbel and Waldroup, 1990).

Ibe and Nwakalor (1987) observed that the relationship between body weight and conformation traits has an important implication in the production of broilers with desired body conformation. The exploitation of local poultry genetic resources for improving economic traits such as body weight, keel length, body depth, and breast width and shoulder length becomes one of the most important in poultry as a cherished breeding goal. (Oke et al., 2011) Growth in shank length, thigh length, and breast width has been found to have precisely followed the same trend as the body weight (Singh and Ohir, 1986, Nwachukwu et al., 2006) .Ayorinde and Oke (1995) noted that feed restriction is commonly applied to pullets to minimize mortality rates and ensure maximum production Of settable eggs. The study was therefore conducted to determine the egg size for optimum broiler production and to determine the effect of feeding regime on the growth traits of broiler chicken at different ages.

MATERIALS AND METHODS

The experiment was conducted at the Poultry unit, Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria, located on latitude 05°29'N and longitude 07°33'east. It is approximately 922m above sea level. Umudike has maximum and minimum daily temperature of 27-36°C and 20-26°C respectively with relative humidity of 57-91% and annual rainfall of2177mm.

A total of 500, one week old egg produced by meat type (Anak titan) breeder flocks were obtained from the farm, weighed and separated or marked into three different egg weights designated A (50-57g), B (58-62g), C (63-68g). The eggs were set in a Western type cabinet incubator. Incubation and hatchery conduction were 0-21 days, temperature of 37.2-39.4°c and relative humidity of 56-60% candling was done on the 7th and 18th day and only fertile eggs were transferred to the hatcher after the last candling. A total of 450 day-old chicks were produced from the three group of eggs weighed A, B and C respectively.

Management of experimental birds

The chicks were brooded for the first two weeks of life under continuous light thereafter they were raised on open-side deep litter. One hundred and ninety two birdsfrom each egg weight group was randomly assigned to two treatments of ad-libitum and restricted feeding (once a day feeding according to NRC, 1994), with 3 replicates per treatment of 32 birds each. The birds were fed commercial broiler starter diet containing 23% CP and 12.5 MJ ME/kg for 4 weeks and finisher diet of 20% CP and 12.5 MJ, ME/kg.

The birds were wing banded and body weight and all other body measurement taken fortnightly early in the morning before feeding the birds. Body weight was taken with a top-loading scale in grammes. All measurement of the legs was taken on the right leg in centimeter with a meter rule. Thigh lengths were measured from the beginning of the block joint to the last ring before the tarsemetatartasus digit. Breast length was taken from the point of the depression of the sharp edge (keel length). Body girth was taken in centimeter using a tape rule, the circumference of the animal posterior to the front leg. Feed intake was taken as the difference between the left over and the total feed presented measured in grammes with a scale. Weight gain calculated as final weight minus weight gain. Feed conversion ratio was calculated as gram feed over gramme weight gain, while mortality was taken as the number of dead birds over number of birds at housing multiplied by 100.

Experimental design and statistical analysis

The experiment was a 3X2 factorial involving 3 different egg size groups with two feeding regimes in a completely randomized design with the following model.

$Y_{ijk} = \mu + t_i + a_j + (ta)_{ij} + e_{ijk}$

Where

Y_{ijk} = individual observation on the birds
μ = overall mean
t_i = effect of the different egg weight
a_j = effect of the feeding regimes
$(ta)_{ij}$ = interaction between different egg weight and feeding regime
E_{ijk} = experimental error (*iind*, o, σ)

Data collected were subjected to a two-way analysis of variance (Steel and Torrie, 1980). Correlation between body weight, feed intake, egg weight and different growth traits were determined using Pearson correlation Analysis (Snedecor and Cochran, 1989).

RESULTS

Results indicate no significant difference (P>0.05) between mean F1 in the three different egg sizes for week 3-7. Significant difference (p<0.05) were observed in week 9 and 11 with birds in group B and C being significantly (p<0.05) higher than A. There were no significant difference (p>0.05) in percent mortality for the different groups of birds throughout the experimental period with B group having lower percent values.

Table 1 - Effect of egg size on weight gain (WG), feed intake (FI), Feed conversion ratio (FCR) and mortality (MORT)

Age week	Egg size group	FI (g)	WG (g)	FCR	MORT (%)
3	A	479.50	315.91	1.62	0.50
		±43.06	±54.87	±0.329	±0.00
	B	498.80	317.14	1.60	0.00
		±46.76	±59.73	±0.188	±0.00
	C	500.70	330.73	1.55	0.50
		±44.64	±56.40	±0.258	±0.00
5	A	767.00	644.94	1.21	3.00
		±132.54	±113.14	±0.218	±1.727
	B	766.60	625.14	1.24	0.00
		±134.63	±114.06	±0.151	±0.00
	C	769.50	648.73	1.20	0.00
		±132.35	±119.97	±0.177	±0.00
7	A	1024.90	996.41	1.66	0.50
		±292.51	±119.10	±0.158	±0.00
	B	1130.00	1033.13	1.19	0.00
		±66.50	±256.19	±0.295	±0.00
	C	1151.50	1140.22	1.03	2.00
		±82.07	±214.72	±0.142	±1.727
9	A	1205.00^{a}	1348.90	0.97	3.00^{a}
		±116.65	±439.33	±0.245	±2.727
	B	1320.00^{b}	1388.13	1.16	0.00
		±67.49	±441.57	±0.392	±0.00
	C	1297.80^{b}	1479.23	0.90	0.50
		±57.09	±275.77	±0.155	±0.00
11	A	1406.50^{a}	1727.91	0.90	0.00
		±126.94	±602.76	±0.292	±0.00
	B	14871.00^{b}	1632.13	1.01	3.00
		±126.78	±500.03	±0.323	±2.00
	C	1476.70^{b}	1898.22	0.79	1.00
		±167.68	±321.56	±0.125	±0.727

a-c means with different superscripts within the same column in each age group are significantly different (P<0.05)

Body weight was not significantly different (P>0.05) between the three egg size groups. The body weight of C (63-68g) was higher than that of A (50-57g) and B (58-62g) throughout the rearing period with 372.05g and 1521.00g for week 3 and 9 respectively. The thigh length (TL) of birds from the three different egg sizes show no significant difference (P>0.05). The shank length (SL) also of the birds did not differ significantly (P>0.05) with an average value 3.73cm and 5.96cm for week 3 and 7 respectively Breast length (BL) took the same pattern of other traits increasing with increase in age of birds with birds in group C having the highest value for all the weeks followed by A and B with no significant difference (P>0.05). The body girth at week 3 showed a significant difference (P<0.05) among the three egg weight groups with birds from egg weight group C, higher than those of A and B, this may be as a result of the high positive correlation between body weight and body girth.

Table 2: Effect of egg size grouping on growth traits of broilers at 3-11 weeks of age						
Traits	**Egg size**	**3**	**5**	**7**	**9**	**11**
Body weight(g)	A	353.50	682.50	1034.00	1386.50	1765.50
	B	355.50	663.50	1071.50	1426.50	1670.50
	C	372.50	690.50	1182.00	1521.00	1940.00
	SEM	16.449	31.634	67.173	126.935	159.589
Thigh length(cm)	A	7.26	9.23	10.93	11.46	12.33
	B	7.23	9.22	11.03	11.60	12.28
	C	7.32	9.36	11.10	11.96	12.88
	SEM	0.155	0.171	0.233	0.243	0.303
Shank length(cm)	A	3.73	4.71	5.87	6.81	7.59
	B	3.59	4.69	5.96	6.83	7.59
	C	3.87	4.93	6.07	7.25	7.91
	SEM	0.093	0.104	0.120	0.180	0.223
Breast length(cm)	A	7.53	9.49	11.04	11.70	12.42
	B	7.42	9.41	11.13	12.00	12.39
	C	7.38	9.73	11.32	12.55	13.30
	SEM	0.184	0.194	0.231	0.283	0.331
Body girth (cm)	A	18.49^{a}	23.24	25.92	28.08	31.04
	B	18.45^{a}	22.80	25.28	29.13	30.79
	C	20.25^{b}	23.05	26.35	30.08	32.72
	SEM	0.413	0.383	0.604	1.03	1.060

$^{a-c}$ means with different superscripts within the same column in each age group are significantly different (P<0.05)

There were no significant difference in feed intake for the various groups except in week 11 where the AF group of A, B and C were significantly different (p<0.05) from each other. Result also indicated no significant difference (P>0.05) between the interaction of the AF and RF groups of the three different egg weight in terms of FI for week 3-9. Weight gain of broilers were not significantly different, however, ad-libitum fed group had higher weight gain than the RF with values ranging from between 344.42-1160.42 (AF), 300.07-952.76g (RF) for week 3-7 respectively. FCR between treatment groups were not significantly (P>0.05) different. Mortality was low for birds in B group than in A and C. The average mortality was lower for RF groups .This is an indication that broilers on restricted feeding had lower mortality as compared to full-fed broilers.

Result indicate no significant difference (P>0.05) for all the parameters measured throughout the period except for the significant difference (p<0.05) which was observed in F1 in week 11 and body weight in week 3.

DISCUSSION

Table 1 shows the effect of egg weight grouping on feed intake (FI), weight gain (WG), feed conversion ratio (FCR), and mortality (MORT) of broilers at age 3-11 weeks. The mean values show increase in F1 with increase on age of birds, this may be because the bigger the birds the higher the feed requirement for growth and maintenance of their body size (Santoso, 2002, Oluyemi and Robert, 2000).The weight gain (WG) values for the three different groups were not significant (P>0.05) and followed the same trend with increase in age of the birds. This observation agree with the work of Oruseibo and Omu (2000) who noted that the weight gain of birds increase in proportion to the amount of feed consumed above that needed for body maintenance. The values of FCR were higher in week 3, 5 and 7 and declined thereafter till the end of the experiment. Smith (1970) had earlier confirmed that feed conversion ratio occurs at the earliest stages of growth and declines thereafter.

The mean value of body weight, thigh length, shank length, breast length and body girth for the three egg weight grouping are shown in Table 2. Birds hatched from larger eggs had higher BW, this agrees with the work of Adeyinka et al. (2000) and Latshaw and Bishop (2001). The thigh length (TL) of birds from the three different egg sizes show no significant difference (P>0.05). The shank length (SL) also of the birds did not differ significantly (P>0.05) with an average value 3.73cm and 5.96cm for week 3 and 7 respectively which was close to 3.6cm and

6.4cm obtained by Ibe and Nwachukwu (1989). Breast length (BL) took the same pattern of other traits increasing with increase in age of birds.

Table 3 shows the effect of feeding regimes, ad libitum (AF) and restricted feeding (RF) on feed intake (FI) weight gain (WG), feed conversion ratio (FCR) and mortality on broilers of three different egg weight groupings. Ad libitum fed group recorded highest feed intake than restricted group which agrees with the works of Ayorinde and Oke (1995) and Kamiaet al. (1996), which showed higher feed intake for chicken on ad-libitum feeding than those of RF groups.

The effect of egg weight grouping and feeding regimes on broiler feed intake, body weight, thigh length, shank length, breast length and body girth is shown in Table 4. Man et al. (1998) and Tina et al. (2004) reported that day-old chick with different weights begin to diverse in body weight from the end of week 3 of rearing. This is because when the birds are hatched, they still operate under the influence of maternal effect due to the presence of the yolk in them but at the end of week 3, this maternal is completely lost and they now exhibit individual characters or effect. This may account for the significant difference noted in week 3, which may assist animal breeders for broiler improvement through selection (Ibe 2007).

Table 3 - Effect of the different egg size grouping and feeding regime on the feed intake, weight gain, feed conversion ratio and mortality of broilers at ages 3-11 weeks.

Parameters	Ages (wks)	Egg size					
		A		B		C	
		AF	RF	AF	RF	AF	RF
Feed intake	3	537.00 ±15.508	485.00 ±5.523	540.60 ±23.006	457.00 ±4.69	543.00 ±2.915	458.400 ±1.140
	5	892.60 ±4.278	614.40 ±8.204	894.00 ±2.738	639.20 ±13.971	895.00 ±1.581	644.00 ±5.568
	7	950.00 ±45.906	1099.80 ±74.212	1164.40 ±30.680	1095.60 ±77.809	1200.20 ±59.213	1103.40 ±76.097
	9	1257.00 ±148.725	1153.00 ±417.07	1380.00 ±5.745	1257.00 ±17.161	1348.200 ±29.575	1247.40 ±10.406
	11	1523.00[c] ±39.051	1290.00[c] ±28.257	1596.00[b] ±26.22	1366.00[d] ±49.168	1634.40[a] ±7.436	1319.00[e] ±32.117
Weight gain	3	303.410 ±52.009	328.410 ±66.555	710.64 ±94.300	268.64 ±31.543	358.23 ±25.00	303.23 ±73.739
	5	690.41 ±125.193	599.41 ±105.629	1200.64 ±199.949	539.64 ±73.195	731.23 ±114.923	566.23 ±75.878
	7	1034.41 ±267.899	958.41 ±133.575	1515.64 ±299.236	865.64 ±232.309	1246.23 ±230.152	1034.23 ±184.945
	9	1525.41 ±549.688	1172.41 ±320.136	1783.64 ±250.040	1260.64 ±597.718	1652.23 ±260.513	1306.23 ±217.790
	11	2004.41 ±630.134	1451.41 ±565.778	1.469.34 ±0.137	1480.64 ±761.695	2088.23 ±185.742	1708.23 ±365.718
Feed conversion ratio	3	1.809[a] ±0.259	1.44[c] ±0.306	1.49[b] ±0.137	1.72[c] ±0.704	1.52[b] ±0.102	1.58[c] ±0.369
	5	1.32 ±0.215	1.09 ±0.166	1.27 ±0.165	1.19 ±0.143	1.24 ±0.203	1.15 ±0.154
	7	1.15[a] ±0.218	1.16[d] ±0.089	0.99[b] ±0.0138	1.39[c] ±.270	0.98[b] ±0.161	1.07[d] ±0.120
	9	0.90 ±0.281	1.03 ±0.215	1.14 ±0.352	1.17 ±0.469	0.83 ±0.117	0.97 ±0.163
	11	0.84 ±0.319	0.97 ±0.279	0.91 ±0.099	1.11 ±0.447	0.78 ±0.060	0.80 ±0.017
Mortality	3	0.50[a] ±0.00	0.50[a] ±0.00	0.00[b] ±0.00	0.00[b] ±0.00	0.50[a] ±0.00	0.50[a] ±0.00
	5	0.50 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
	7	0.00[c] ±0.00	0.50[b] ±0.00	0.50[b] ±0.00	0.00[c] ±0.00	0.00[c] ±0.00	5.00[a] ±0.00
	9	7.00[a] ±0.00	0.00[c] ±0.00	0.00[c] ±0.00	0.00[c] ±0.00	0.50[b] ±0.00	0.00[c] ±0.00
	11	0.00[c] ±0.00	0.00[c] ±0.00	10.0[a] ±0.00	5.00[b] ±0.00	5.00[b] ±0.00	5.00[b] ±0.00

[a-c] means with different superscripts within the same column in each age group are significantly different (P<0.05). AF=Ad libitum feeding, RF=Restricted

Table 4 - Effect of egg size grouping and feeding regime on feed intake, body weight, thigh length, shank length, and breast length and body girth

Parameters								
Egg size		A		B		C		
Feed type	Ages (WK)	AF	RF	AF	RF	AF	RF	SEM
Feed intake	3	53.700	458.00	540.00	457.00	543.00	458.00	5.27
	5	892.60	641.40	894.00	639.20	895.00	644.00	3.28
	7	950.00	1099.80	1164.40	1095.60	1200.20	1103.40	80.58
	9	1257.00	1153.00	1383.00	1257.00	1348.20	1247.40	28.97
	11	1523.00^{c}	1290.00^{e}	1596.00^{b}	1366.00^{d}	1634.40^{a}	1319.00^{e}	14.74
Body weight	3	341.00^{b}	366.00^{c}	404.00^{a}	307.00^{d}	400.00^{a}	345.00^{c}	23.26
	5	728.00	637.00	749.00	578.00	773.00	608.00	44.74
	7	1072.00	996.00	1239.00	904.00	1288.00	1076.00	94.98
	9	1563.00	1210.00	1554.00	1299.00	1694.00	1348.00	178.51
	11	2042.00	1489.00	1822.00	1519.00	2130.00	1750.00	225.69
Thigh length	3	7.22	7.30	7.26	7.20	7.38	7.26	0.22
	5	9.52	8.94	9.66	8.78	9.82	8.90	0.34
	7	10.94	10.92	11.44	10.62	11.40	10.80	0.33
	9	11.68	11.24	12.00	11.20	12.28	11.64	0.34
	11	12.82	11.84	12.66	11.90	13.24	12.52	0.43
Shank length	3	3.64	3.82	3.82	3.36	4.00	3.74	0.13
	5	4.90	4.52	5.00	4.38	5.18	4.68	0.15
	7	5.88	5.86	6.18	5.74	6.30	5.84	0.17
	9	7.04	6.58	7.18	6.48	7.40	7.10	0.25
	11	7.90	7.28	7.74	7.44	8.18	7.64	0.32
Breast length	3	7.32	7.74	7.48	7.36	7.56	7.00	0.26
	5	9.68	9.30	9.94	8.88	10.18	9.28	0.28
	7	11.04	11.04	11.62	10.64	11.60	11.04	0.33
	9	12.06	11.34	12.60	11.40	13.06	12.04	0.40
	11	13.00	11.84	12.88	11.90	14.20	12.40	0.47
Body girth	3	18.48	18.50	19.08	17.82	20.50	20.00	0.58
	5	23.40	23.08	23.82	21.78	23.86	22.24	0.54
	7	25.98	25.86	26.44	24.12	26.74	25.96	0.85
	9	28.62	27.54	30.02	28.24	31.52	28.64	1.46
	11	32.26	29.82	31.54	30.04	34.00	31.44	1.50

$^{a-e}$ means with different superscripts within the same column in each age group are significantly different (p<0.05). A, B and C = egg size grouping. AF = ad libitum feeding. RF = restricted feeding. SEM = standard error of mean

Table 5 - Correlation between body weight and linear body measurement of broilers of A (50g-57g) group at Ages 3-11 weeks

Bodyweight group		BW	TL	SL	BL	BG	FI
A	BW	1.000					
	TL	0.900**	1.000				
	SL	0.944**	0.969**	1.000			
	BL	0.920**	0.983**	0.977**	1.000		
	BG	0.935**	0.923**	0.942**	0.931**	1.000	
	FI	0.460	0.528	0.613	0.586	0.453	1.000
B	BW	1.000					
	TL	0.900**	1.000				
	SL	0.944***	0.969**	1.000			
	BL	0.920**	0.983**	0.977**	1.000		
	BG	0.935**	0.923**	0.942**	0.931**	1.000	
	FI	0.460	0.528	0.613	0.586	0.453	1.000
C	BW	1.000					
	TL	0.906**	1.000				
	SL	0.921**	0.951**	1.000			
	BL	0.965**	0.929**	0.934**	1.000		
	BG	0.878**	0.821**	0.875**	0.864**	1.000	
	FI	0.648*	0.522	0.464	0.706*	0.543	1.000

BW= Body weight, TL= Thigh length, SL= shank length, BL= Breast length, BG= body girth, FI= Feed intake. * P<0.05, ** P<0.01

The correlation for the different growth traits including body weight and feed intake for the three different egg weight groupings, A-C, are shown in Tables 5. Correlation coefficients for the three egg weight grouping (A, B, C) were high and positive between body weight and each of the growth traits studied, supporting the observation by Ibe and Nwachukwu (1989) and Adeniji and Ayorinde (1990) that there exist high positive correlation between body weight and each of the correlated traits. According to Khan (2003), moderate to high estimate of heritability of 3rd week body weight together with high positive genetic correlation observed in this study suggest the need for selection for increased three week body weight required to achieve genetic improvement in market weight of broiler.

Correlation coefficients for the three egg weight grouping (A, B, C) were high and positive between body weight and each of the growth traits studied.

CONCLUSION

From the result of this study it can be noted that the different egg size from which the birds were hatched may impact on the performance of the birds and also quantity of feed given (AF and RF) had a direct influence on the performance of the birds irrespective of the egg weight on all the growth traits studied. Feed intake of birds increased with BW and with age of the birds. Birds with 63-68g egg weight had higher mean values for all the growth traits measured than birds with 58-62g and 50-57g and showed positive significant correlation between body weight and all the other body traits. It is therefore suggested that birds with higher initial body weight placed on AF like those in group C egg weight should be used for broiler production since they will give optimum production in the humid tropical environment.

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MONITORING FEED NUTRIENT CONTENT OF AVAILABLE COMMERCIAL POULTRY FEEDS IN BOTSWANA

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ABSTRACT: *Nutrient quality in a feedstuff is the concentration of that nutrient in quantities that are sufficient for normal metabolic activities of a particular animal. Hence the study was carried out to determine nutrient quality of various locally available concentrate poultry feeds in the market and compare determined feed contents with nutrient values on labels. The samples were obtained from broiler farmers in Gaborone region. Mean analysis values from manufacturer A feeds were 19.64, 3.29, 0.19 and 0.43 for starter, 16.39, 3.98, 0.11 and 0.57 for grower, and 16.94, 4.27, 0.16 and 0.48 for finisher in g/100g on dry matter basis, crude protein, fats, phosphorus and calcium respectively. Feed label stated 22, 2.5, 0.6 and 8 for starter, 20, 2.5, 0.55 and 0.8 for grower and 18, 2.5, 0.5 and 0.8 for finisher in g/100g on dry matter basis for crude protein, fats, phosphorus and calcium respectively. Grower feeds from manufacturer B contained 18.33, 2.65, 0.24 and 0.66 in g/100g as compared to feed label values of 18.0, 2.5, 0.55 and 0.7 in g/100g on dry matter basis for crude protein, fats, phosphorus and calcium respectively. Manufacturer C finisher feed also contained 18.16, 4.1, 0.17 and 0.52 in g/100g on dry matter basis for crude protein, fats, phosphorus and calcium respectively. The quantity of minerals was found to be lower in all feeds from all manufacturers with manufacturer A lower in almost all other organic nutrients (except fats) compared to values stated on feed labels.*

ORIGINAL ARTICLE

Keywords: *Nutrient content, commercial poultry feed, Botswana.*

INTRODUCTION

There is a need for good manufacturing practice of animal feed during procurement, handling storage, processing and distribution of formulated and compound animal feeds to ensure high feed quality. There is a need for consistent quality animal feed and this can be achieved by implementing sound quality control procedures. Quality animal feeds can only be made from the use of quality feed ingredient sources and not from spoilt or contaminated ingredients. Selection and purchasing of raw ingredients including ingredient quality control is essential. The ingredients used for animal feed must be wholesome and safe. It is inevitable that the quality of ingredients will vary, even from the same supplies from batch to batch. Therefore, it is important that this variability should be characterized and monitored. There is a need for periodic sampling to verify the ingredient and specifications. Nutritional and analytical characteristics of feeding stuffs are necessary. Also, the specifications should include origins, sources and contaminations if any. All ingredients should be inspected and labeled. Moldy ingredients should not be used. This is because of mycotoxins in moldy feedstuffs may have detrimental effects on animals even at very low concentrations. Manufacturing quality control must insure that the feed produced will be consistently of a quality appropriate to the species fed. Animal feed processing should include a comprehensive system of record keeping documenting that the appropriate standards of a formula are being met throughout the period of manufacturing to make the product fully traceable. Feed ingredients which are dry before processing should be kept dry and cool and used on a first-in, first-out basis. As a general rule the moisture percentage should be less than 13% particularly in the humid areas.

There are different physical forms of dry animal feeds. It may be a meal, cake, pellets, crumbles, range cubes, blocks or scratch. A complete monogastric feed consists of grains, plant proteins, animal proteins, grain byproducts, macrominerals, specialty products, vitamins and trace minerals. Supplements usually are compounded from plant proteins, animal proteins, grain byproducts, macrominerals, specialty products, vitamins and trace minerals. A base-mix consists of grain byproducts, macrominerals, specialty products, vitamins and trace minerals. A premix consists of specialty products, vitamins and trace minerals. Grains are feeds such as maize, millet, sorghum. Plant proteins are feeds like soya bean meals, oilseed cakes like cottonseed cake, sunflower seed meal etc. Animal proteins are feeds like fishmeals, milk powder etc. Grain byproducts are dry mill byproducts from dry maize milling for example homing feed, milo germ from dry sorghum milling. Wet mill byproducts like gluten meals from fermented grain products dry brewer's spent grains. Macrominerals are from limestone (calcium), oystershell rock phosphate (calcium and phosphorous), dicalcium phosphate (calcium and phosphorous), Monosodium phosphate (phosphorous), common salt (sodium and chlorine), iodized salt contains iodine (0.007% iodine). Specialty products may include antibiotics, chemotherapeutic agents and others. Vitamins may be purchased individually or as mixtures. Trace mineral vary in utilization or biological availability. Factors to consider in biological availability include solubility in water or dilute acid, effectiveness in preventing or curing deficiency symptoms and tissue concentrating effect in animals.

Balanced diets entails the mixture of the right proportions of various ingredients to produce diet with all essential nutrients ideal for normal functioning of a concerned or particular animal. Meanwhile, farmers who produce their own feeds on the farms need to know chemical composition of each crop on farm, as this is essential in planning what crop types to plant in order to meet balanced diet requirement. Although chemical analysis is vital, nutritional value of feeds provides information on how feedstuff are digested and metabolized by the animal, mainly through interpreting differences between the input into and output out of an animal. Unbalanced diets may also produce economic loss in terms of animal health, feed conversion efficiency and, ultimately, the output of animal products, (Gizzi and Givens, 2004). Formulating of a ration is a matter of combining feeds to make a ration that will be eaten in the amount needed to supply the daily nutrient requirements of the animal (Lalman and Sewell, 1993). The objective of this study is to evaluate nutrient composition of chicken concentrate feeds and compare values obtained with the manufacturer's feed label values.

MATERIALS AND METHODS

The experiment was conducted in Botswana College of Agriculture (BCA) which is located at in the southern part of Botswana. This site is at an altitude of 991m (S 24.58455; E 025.94304). The average monthly temperature ranges from18^{0}C minimum to 33.4^{0}C maximum. The climate is semiarid which experiences unreliable rainfall. The type of vegetation in this area is mixed acacia/combretum tree savanna. The average annual rainfall is 450 mm

Feed samples were collected from BCA farm and nine other farms around Gaborone, and then the nutrient analysis was done in the College laboratory. Samples of broiler starter, grower, finisher and layers mash were collected in *ziplock* polythene plastics to prevent any form of contamination from the farm, grounded to pass through 1mm sieve and stored in bags before chemical analysis. Contamination of feeds was avoided by sampling from freshly opened feed bags. Four replicates of each feed from three manufacturers were sampled. Mean nutrients composition was compared to the tag values for significance differences. The dry matter, water, crude protein (Kjeldahl method), neutral detergent fiber (NDF), acid detergent fiber (ADF), ether extract (Soxhlet method), ash, calcium (Ca), phosphorus (P) and magnesium (Mg) were analyzed. Rrepresentative samples of broiler mash and layer's mash were weighed and put in the oven at 70^{o}C for 48 hours. Feed samples were analysed according to the procedures of AOAC (1996). Calcium was analyzed using ICP (Inductively Coupled Plasma/ Optimal Spectroscopy) after digesting the samples. Determination of phosphorus was carried out using UV-Vis Spectrophotometer. 1ml of the standard solutions was pipetted accurately into clean dry vials. 1ml of each sample was pipetted into another set of clean vials. To each of these vials (standards as well as samples) 10ml of dilute chloromolybdic acid was added. 1ml of stamous chloride was added to the vials, first to the standards then the samples. The solutions were left for 10 minutes. The absorbance was then read on the spectrophotometer, reading the standards first then the samples. The design was the complete randomized block design. Data collected was analyzed using ANOVA (analysis of variance), (SAS, 2004).

RESULTS AND DISCUSSION

Poultry feed ingredients include energy concentrates such as corn, oats, wheat, barley, sorghum, and milling by-products. Protein concentrates include soybean meal and other oilseed meals (peanut, sesame, safflower, sunflower, etc.), cottonseed meal, animal protein sources (meat and bone meal, dried whey, fish meal, etc.), grain legumes such as dry beans and field peas, and alfalfa. Grains are usually ground to improve digestibility. Soybeans need to be heated-usually by extruding or roasting-before feeding in order to deactivate a protein inhibitor. Soybeans are usually fed in the form of soybean meal, not in "full-fat" form, because the valuable oil is extracted first. Whole, roasted soybeans are high in fat which provides energy to the birds.

Table 1 shows the ingredients and their amounts used in commercial poultry feeds as indicated on the bag labels and Table 2 show the analyzed results of the same feeds. As indicated in Tables 1 and 2 the amounts of ingredients as labeled and the amount of ingredients analyzed does not match. This simply means that what is indicated in the label does not mean it is the actual content amount of the ingredients stated. Analyzed protein content of Starter's mash was 19% and labeled protein content was 22%. Kingori *et al* (2003) stated in a stress free environment, given adequate intake of essential nutrients, growth will increase until a genetically determined upper limit is reached, but feeding animals below their protein requirement does not improve protein utilization. Protein deficiency in a feed reduces growth as a consequence of depressed appetite and thus intake of nutrients.

Table 1 - Composition in commercial poultry feeds as indicated on the bag labels

Ingredients	Starter's mash	Layer's mash
Protein (%)	22	16
Moisture (%)	12	12
Fibre (%)	5.0	7.0
Calcium (%)	0.8	4.5
Phosphorus (%)	0.7	2.5
Lysine (%)	1.1	0.6

Chicken feed usually contains soybean meal which is a by-product of the oilseed industry. In the industry, soybeans are dehulled and cut into thin pieces (flaked) to improve the action of the solvent (usually hexane) which is passed through the soybean to extract the valuable oil. Vegetable oils such as soybean oil are used for edible and industrial purposes. The soybean is then toasted as a method of heat treatment to deactivate an inhibitor which would otherwise interfere with protein digestion in the animal.

Feeding the above protein requirements may not result in an increase in protein deposition, but nitrogen excretion through the urine increases rapidly (Bikker *et al*., 2004). The amino acid concentration of typical maize-soya diets (160 and 180g CP/kg) meets the requirements of growing layer chickens (NRC, 1984).

Table 2 - Proximate analysis of the Starter's mash and Layer's mash

Ingredients	Starter's mash	Layer's mash
Dry Matter (%)	90.05	84.65
Moisture (%)	9.95	15.35
Protein (%)	19	12
Calcium (%)	0.5	2.5
Phosphorus (%)	0.2	0.3

Calcium (%) for chicks as indicated on bag labels and analyzed was 0.8% and 0.5% respectively. Calcium (%) for layers as indicated on bag labels and analyzed was 4.5% and 2.5% respectively. Calcium is important for proper egg shell formation. The calcium requirement will vary with the age of the bird, environmental temperature, rate of lay and egg size. A general recommendation for laying hens is a daily calcium intake of 3.4 grams. After 40 weeks of age, this intake should be increased to 3.8grams. Phosphorus (%) for chicks as indicated on bag labels and analyzed was 0.7% and 0.2% respectively. Phosphorus (%) for layers as indicated on bag labels and analyzed was 2.5% and 0.3% respectively. It is necessary to assure that the phosphorus level in the diet is not excessive since excess phosphorus tends to inhibit calcium absorption from the gastro-intestinal tract tract. For layers a level of 0.3% to 0.4% available phosphorus, which is equivalent to 0.5% to 0.6% total phosphorus, is adequate. Feed analysis is important for quality assurance in feed manufacturing and for identifying the presence and concentrations of undesirable substances in feeds which can adversely affect animals' health and productivity (Adesogan, 2002). Table 3 shows the nutrient contents of all feeds sampled and analyzed. Table 4 shows the nutrients on the feed labels as presented by the manufacturer. Table 5 shows composition of broiler starter from manufacturer A. Table 6 highlights the suggested nutrient specification for different classes of poultry.

Chemical analysis of starter mash revealed low crude protein (CP), calcium (Ca) and phosphorus (P) content as compared to manufacturer A feed label values with a difference of 2.36, 0.37 and 0.41 g/100g respectively. Dry matter and fats are above the stated amounts by a difference of 3.2 and 0.79 g/100g. The levels of crude protein, calcium and phosphorus content were also lower than the minimal levels (21.0, 1.0 and 0.6 g/100g CP, Ca, and P respectively) recommended by the National Research Inventory (NRI, 1988) to be optimum for normal broiler chick.

Grower mash from manufacturer A, DM and fats were above the stated amounts by a difference of 2.3 and 1.48g/100g. Ca, P and CP are lower by 0.23, 0.44 and 3.61 g/100g respectively from feed label values. CP, DM and fats are above feed label values by 0.33, 1.0 and 0.14 g/100g respectively in manufacturer B feeds. Ca and P are lower by 0.04 and 0.31 g/100g respectively.

Table 3 - Chemical composition of broiler in g/100g on dry matter basis.

Feed class	Manufacturer	DM	NDF	ADF	CP	FATS	ASH	Mg	P	Ca
Starter	A	91.2± 0.98	20.50± 1.48	7.53± 0.89	19.64± 1.914	3.29± 0.558	4.21± 0.49	0.11± 0.03	0.19± 0.035	0.43± 0.07
Grower	A	90.32± 042	24.31± 1.48	7.72± 0.867	16.39± 0643	3.98± 028	4.20± 0.32	0.11± 0.00	0.11± 0.03	0.57± 0.12
	B	89± 0.66	17.38± 3.28	7.92± 1.37	18.33± 1.02	2.65± 0.44	5.5± 0.51	0.12± 0.004	0.24± 0.04	0.66± 0.19
Finisher	A	90.6± 0.51	24.74± 1.04	7.75± 0.30	16.94± 0.57	4.267± 0227	4.146± 0.573	0.114± 0.007	0.16± 0.015	0.48± 0.037
	C	88.8± 0.88	24.33± 1.80	9.392± 0.0522	18.16± 0.98	4.1± 0.39	4.53± 0.99	0.12± 0.01	0.17± 0.03	0.52± 0.064

Table 4 - The nutrient concentration of commercial poultry mash as stated on feed labels by manufacturer g/100g

Feed class	Manufacturer	DM	H_2O	CP	FATS	P	Ca
Starter	A	88	12	22	2.5	0.6	0.8
Grower	A	88	12	20	2.5	0.55	0.8
	B	88	12	18	2.5	0.55	0.7
Finisher	A	88	12	18	2.5	0.5	0.8
	C	–	–	–	–	–	–

Table 5 - Mean composition of starter mash produced by manufacturer A in g/100g on dry matter basis

Variable	Mean	Standard deviation	Minimum	Maximum
DM	91.20	0.98	90.00	92.40
H_2O	8.80	0.98	7.60	10.00
NDF	20.50	1.48	18.93	22.86
ADF	7.53	0.89	6.90	8.91
CP	19.64	1.91	16.63	21.59
FATS	3.29	0.56	2.65	3.95
ASH	4.21	0.49	3.49	4.76
Mg	0.11	0.03	0.08	0.16
P	0.19	0.03	0.15	0.23
Ca	0.43	0.07	0.34	0.52

Table 6 - Suggested nutrient specifications for different classes of poultry*								
Nutrient composition, %	Diet type							
	Layers			Broiler breeder			Broiler	
	starter	grower	Layer ratios	starter	grower	layer	starter	finisher
ME (Kcal/kg)	2800	2800	2750	2800	2800	2800	2800	2800
CP	17.5	16	17	18.5	16	16	20	18.5
CF (max)	5	5	5	4.5	4	4	5	5
Ca	1	1	3.6	0.9	0.95	3.2	0.9	0.9
P (available)	0.47	0.4	0.40	0.45	0.40	0.40	0.42	0.38
Linoleic acid	0.8	1.3	0.8	0.7	1.0	1.2	0.8	0.70
Lysine	1.00	0.70	0.76	1.00	0.76	0.78	1.00	0.96
Methionine	0.40	0.33	0.35	0.45	0.36	0.38	0.50	0.48
Meth+ Cyst	0.67	0.58	0.60	0.74	0.60	0.62	0.83	077

*Source: NRC, 1984.

Table 7 - Nutrient requirements of broilers*			
Nutrient	0 to 3 weeks old	3 to 6 weeks old	6 to 8 weeks old
Metabolizable energy, Mcal/Kg	3200	3200	3200
Crude protein, %	23	20	18
Lysine, %	1.1	1.0	0.85
Methionine, %	0.50	0.38	0.32
Methionine + Cystine, %	0.90	0.72	0.60
Linoleic, %	1.00	1.00	1.00
Calcium, %	1.00	0.90	0.80
Magnesium, %	600	600	600
Nonphytate phosphorus	0.45	0.35	0.30
Niacin, mg	35	30	25

*Source: Perry, Cullison and Lowrey (2004)

Finisher's mash content of CP, P, and Ca were lower by 1.04, 0.34 and 0.32 g/100g respectively from the manufacturer A feed label values. Fats were above the stated feed label value by 1.77 g/100g. NRI (1988) suggested that poultry feeds produce good quality broiler if they contain a maximum of 21%, 5%, 8%, 1%, 0.6% and 1.2%, a minimum of 18%, 4%, 0.9%, 0.6% and 0.8% crude protein, crude fat, crude fiber, calcium, phosphorus, and lysine respectively. On the other hand layers chicks with an age of range of 0-8 weeks would need diet which contain a maximum of 18.5%, 4%,8%, 1%, 0.7% and a minimum of 17%, 4.5%, 0%, 0.9%, 0.65% and 0.85% crude protein, crude fat, crude fiber, calcium, phosphorus and lysine respectively.

All the feeds contain excessive amounts of fiber as indicated by the neutral detergent fiber and acid detergent fiber content, which is above the recommended content of five percent. Chemical analysis revealed lower nutrient concentration in all feed classes from manufacturer A (except fat content, which is higher). Feeds from manufacturers B and C had mineral contents that were much lower than what was indicated on the feed labels. However, these lower nutrient contents indicated that farmers were sold feeds of lower nutrients quantity. Since any deficit of one nutrient could compromise functional value of other sufficient nutrients. Hence, feeds are of lower monetary value, since the prices attached should be in relation to the nutrient composition of the feeds as stated on the feed labels. Quality control is essential at all stages in the production of compound feed if the maximum and most efficient returns are to be obtained by the feed compounder and farmers.

CONCLUSION

Feeds nutrient concentration do not conform to the recommended (Perry *et al.*, 2004) concentration, mainly in minerals. However, manufacturer A was found to be most deficient in almost all nutrients compared to manufacturers B and C. The results obtained did not match all the manufacturer's feed tag labels. For optimum growth of poultry, recommended amounts of protein, calcium and phosphorus should be fed. Protein amounts of 160g/kg and 220g/kg for layers and starters respectively are recommended. Manufacturers need to improve the nutrient concentration to at least the minimal recommended amounts for normal broiler growth and indicate the actual feed nutrients composition values on their feed tags.

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NUTRITIONAL PRELIMINARY CHARACTERIZATION OF SOME VARIETIES OF DATES AND PALM DOWNGRADED AS RUMINANT FEED

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ORIGINAL ARTICLE

ABSTRACT: *In Saharan regions, the date palm which forms the backbone of agriculture, offers a wide range of agricultural by-products, traditionally used for domestic purposes. The determination of chemical composition and nutritional value of these byproducts for rational use in feeding livestock is needed. The analysis showed that the byproducts of palm have total nitrogen content (CP), lipid (FAT) and (CB, NDF, ADF and ADL) also with a higher nutritional value close to that of straw and hay. The scrap value of dates offers a relatively high energy (0.87 UFL / kg DM) which is comparable to the concentrate feed but with relatively low levels of nitrogen or the need for supplementation or nitrogen treatment.*

Keywords: *Food, chemical, palm oil, scrap dates, nutritional value*

INTRODUCTION

The date palm is a hardy tree adapted to drier parts of the world. It is a monocot tree, the family or palmaceae phoenicicacées coryphinées subfamily, genus and species phoenix dactylifera. It is the main source of living of the Saharan population and for their livestock. Use of date palm by-products in animal feed has long been practiced by local farmers in a traditional way (Chehma et al., 2000). By-products or waste of dates or sorting gap are conventionally used as adjuncts in southern Tunisia (Genin et al., 2004) and are mainly waste of dates, followed, to a lesser extent, pedicels dates and dry palms (Boudechiche et al., 2008a).

The study of their nutritional value has yielded results placing the scrap dates in the category of concentrated energy feed with 0.94 UFL / kg of dry matter. In this same context, Genin et al. (2004) reported that there is a high concentration of energy waste in dates and nuclei, high levels of fiber in the stalks and leaves. By cons, in all cases the levels of crude protein (CP) are low (3 to 6.5% DM).

The results of the nutritional value obtained by Harrak et al. (2005); Boudechiche et al.(2008a and b) rank the byproducts of date palm in 2 categories; scrap dates as concentrated energy food, and the palms dry and coarse stalks as feed, similar to straw or hay of poor quality. Indeed, scrap dates, recording a 0.85 UFL, 0.84 UFL, and 0.81 UFV / kg DM can be classified as concentrated energy, which can even replace the grain (barley, oats. .. etc..), while dry palms and pedicels record, respectively, values of PDIE, 43.87 and 26.29 g / kg DM, against 35.44 g / kg DM for barley straw , the energy values of 0.20 UF, 0.39 UFL, 0.31 and 0.34 UFV, 0.45 UFL, 0.36 against 0.35 UFV, 0.50 UFL, 0.50 to UFV barley straw and nitrogen values in g / kg DM, 22.94 and 20.03 against 16.51 for barley straw. However, we must note that these products are low in nitrogen; their use requires supplementation or nitrogen treatment. Chehma et al. (2003) showed that the refuse of dates can be incorporated in diets of young sheep for fattening. Indeed, their use in place of barley in the diets of growing sheep has resulted in superior performance by weight and better feed efficiency. The three rations allow increasing amounts of waste growth rates higher than those obtained with the diet based on barley alone. That is a wise use of these products as part of our work, which is a study of the chemical composition and nutritional value, for use in livestock feed.

MATERIALS AND METHODS

Rootstock

Twenty varieties: Ten-product Palms (Angou, Aligue, Degla, Horra, Gondi, Akhwat, Arechti, Ghares, Gasbi, and Kintichi) and ten scrap dates (Bejou, Kintichi, Deglat, Manakher, Zehdi, Akhwat, Khalt, Kenta, Tantabecht, Aligue) from Tunisian oasis were selected for this study.

Analytical Methods

Samples of different plant species studied were analyzed for their dry matter (DM), organic matter (OM) mineral content (MM), total nitrogenous matter (CP) and lipid (FAT) according to AOAC (1990). The total fiber (NDF) are obtained after dissolution under the action of a neutral detergent sodium content of Acid Detergent Fiber (ADF) was measured in the presence of cetyl trimethyl ammonium Brome and lignin (ADL) is determined on the ADF residue subjected to the action of sulfuric acid solution at 72% (Van Soest et al., 1991).

The energy and protein values of oat hay expressed UFL / kg DM have been deduced by applying the formula Sauvant (1981).

UFL / kg DM = (1.218 (100-water - MM) + 0.11 CP - 1.81CB + 1.26 FAT) / 100
PDIE (g / kg DM) = 5.14 CP - (4.8 * CP * 0.4) - 0.8 CB + 68.8 MO/100
PDIN (g / kg DM) = 7.44 CP - (2 * CP * 0.4) + 1.2 MO/100

RESULTS AND DISCUSSION

Chemical composition

The dry matter of different varieties of palm by-products and scrap dates ranged from 83.8% to 90.9% which is comparable to the results of Belguedj (2000) and Boudechiche et al. (2008b) for the byproducts of Moroccan and Algerian oasis . These percentages are relatively high dry matter tell us about their freshness, hence their use as such, without drying. The levels of crude protein (CP) are higher for the byproducts of palm (11.53% for Kintichi and 18. Aligue to 03%) these values are close CP seed protein. While scrap dates for percentages of CP very low (3.33 to 6.31%). However, all varieties have been several studies by different authors in various countries have shown that the dates were deficient in protein and should be supplemented by a supply of nitrogen. It is therefore necessary to correct the deficit protein in order to enhance their dates and waste in animal feed by mixing them with food to fill this gap (Estanove, 1990).

On the lipid content (FAT), it is acceptable to the byproducts of palm and very low or even zero for scrap dates. This result concurs with that of Chehma et al. (2007). In terms of CB, we find that the results obtained have a very low rate for scrap dates with an average 7.43% DM of varieties, against relatively high rates for the dry stalks of palms that record an average grade of 34.11% which is similar to what is reported by Genin et al. (2004) and Chehma et al. (2007). This low rate of CB scrap dates is because they represent a much richer fruit sugar cytoplasmic. For the composition of the wall, we see that dry palms are the greatest rate of NDF. This is due to the physical consistency of the 4 sub-products, which depends on the phenological part occupied by each of these sub-products (pedicel and fruit). Similarly, for the same reasons, the content of other components of the wall ADF and ADL is variable, and dry palms are always higher rate, while trash dates record the lowest rates as shown in Table 1.

Food values

The scrap of dates offers a relatively high energy value (0.87 UFL / kg DM) which is comparable to the concentrate feed (Table 2). That is why it is used as an energy supplement in lieu of barley, mainly for the sheep (Boudechiche et al., 2008b). While for the by-product of palm, they are compared to straw and hay of poor quality for their low energy value. The amount of PDIE are comparable to the pedicels of palms and differential sorting of dates, they are in the ranges (70 to 90 g / kg DM) As for nitrogen values, it is high for the by-products of palm and very low for scrap dates so their use requires supplementation or N- treatment Chehma et al. (2003).

Table 1 - Chemical composition (% DM) and wall-products of palm and waste of dates

		DM (%)	MM	OM	CP	FAT	CB	NDF	ADF	ADL
Byproducts of palm	Angou	86.54	5.3	94.6	15.42	6.6	36.55	89.44	65.3	20.45
	Aligue	89.3	5.44	94.55	18.03	5.6	30.5	83.04	53.88	22.45
	Degla	84.94	5.74	93.06	15.14	6.94	31.22	88.87	64.12	21.02
	Horra	85.44	3.46	96.54	16.13	5.74	33.5	85.12	58.9	23.11
	Gondi	85.63	3.46	96.54	12.56	5.2	33.1	87.1	61.58	25.4
	Akhwat	84.12	9.63	90.37	12.56	5.2	33.89	82.5	66.02	22.78
	Arechti	89.2	3.62	96.38	16.26	4.2	35.25	88.99	58.7	21.21
	Ghares	81.28	5.3	94.7	13.48	4.7	36.2	89.01	66.47	22.02
	Gasbi	88.76	7.98	92.02	14.77	4.7	34.34	89	67.12	23.28
	Kintichi	90.92	2.97	92.99	11.53	4.4	36.55	86.86	66.03	25.88
Waste of Dates	Bejou	84.3	3.6	96.4	3.78	0.24	9.53	24.39	12.94	8.03
	Kintichi	89.2	2.97	97.03	3.33	0.42	8.5	21.6	13.6	6.51
	Deglat	90.3	2.28	97.72	4.33	0.08	7.4	22.2	18	4.82
	Manakher	85.1	2.44	97.56	5.07	0.7	6.2	22.1	17.7	3.92
	Zehdi	87.7	3.68	96.22	6.31	0.06	5.88	24.06	14.03	4.06
	Akhwat	87.5	2.5	97.5	4.93	0.4	9.6	26.35	17.8	5.01
	Khalt	88.5	3.56	96.44	3.94	0.6	7.7	27.1	12.22	6.75
	Kenta	86.8	2.38	97.62	4.53	0.32	8.8	26.6	17.7	4.44
	Tantabecht	83.8	1.86	98.14	4.3	0.07	5.5	25.23	17.77	4.74
	Aligue	88.3	4.04	95.96	3.74	0.5	5.22	22.12	18.12	3.82

Table 2 - Values of food-products and waste palm dates

		UFL /kg DM	PDIE, g/kg DM	PDIN, g/kg DM
Byproducts of palm	*Angou*	0.30	89.5	103.52
	Aligue	0.45	99.16	120.85
	Degla	0.4	87.8	101.64
	Horra	0.36	91.55	108.25
	Gondi	0.367	80.37	84.55
	Akhwat	0.25	75.5	84.4
	Arechti	0.35	90.46	109.12
	Ghares	0.21	79.59	90.64
	Gasbi	0.31	83.39	99.17
	Kintichi	0.29	71.86	77.67
Waste of Dates	*Bejou*	0.86	78.3	26.03
	Kintichi	0.88	70.67	23.27
	Deglat	0.91	70.14	29.83
	Manakher	0.88	78.48	34.84
	Zehdi	0.9	81.8	39.85
	Akhwat	0.83	75.28	33.9
	Khalt	0.87	72.88	27.31
	Kenta	0.84	74.71	31.25
	Tantabecht	0.88	76.97	29.72
	Aligue	0.94	73.89	25.98

CONCLUSION

The results obtained show that the refuse of dates can be incorporated into the rations of farm animals in arid areas during periods of food unavailability replacing all or part of the concentrate imported reverberating both beneficial the national economy and to provide an outlet for the sector dates. Indeed, for a balanced diet, one must note that these products are low in nitrogen; their use requires supplementation or nitrogen treatment. It would be interesting scientifically to continue this work to better characterize these products by determining the kinetics of production of total gas and methane, digestibility "situ" of organic matter, total volatile fatty acids and metabolizable energy.

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INFLUENCE OF DIETARY CALCIUM LEVELS ON BONE DEVELOPMENT IN BROILER BREEDER HENS

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ABSTRACT: *A study was conducted to determine the effects of three dietary calcium (Ca) levels on bone characteristics of 198 broiler breeder hens during the laying period. The pullets in each experimental diet were randomly divided into three treatment groups with 1.5, 2.5 and 3.5% dietary Ca (66 birds per treatment) fed from 23 to 60 weeks of age. Treatments were arranged in a 2 x 3 factorial block design (effect of 2 ages and 3 Ca levels). Three types of breeder diets containing 1.5, 2.5 and 3.5% Ca were fed from 23 to 60 weeks of age (laying period) and these include: breeder phase 1 (23 to 34 weeks), breeder phase 2 (35 to 46 weeks) and breeder phase 3 (47 to 60 weeks). The diets were isocaloric and isonitrogenous but varied only in Ca and phosphorus (P). Feed was provided in restricted amounts in accordance with the breeders' recommendations. At 35 and 60 weeks of age, 12 birds were randomly selected from each treatment and killed by cervical dislocation and tibiae (left and right) and right humeri from each bird excised. Parameters studied were bone weight, bone length, bone midshaft width, bone breaking strength (BS), bone stress, percent bone, true cortical area and bone ash percentage. These results showed no (P>0.05) beneficial effects of feeding increased Ca levels on all bone parameters except BS. Feed intake and body weight of broiler breeder hens were lower when 1.5% Ca was included in the diet. It seems that 2.5% Ca (4 g Ca/hen/day) is adequate to stimulate feed intake and support growth of broiler breeder hens. Bone stress decreased (P<0.081) with age, indicating that the degree of bone mineralisation was greater at 35 weeks compared to 60 weeks.*

ORIGINAL ARTICLE

Keywords: *Bone dimensions, bone strength, bone stress, calcium, phosphorus*

INTRODUCTION

There are several different types of bones in laying hens. The main types that provide structural integrity are cortical and cancellous (or trabecular) bones, both of which are forms of lamellar bone. These bones are formed during growth, but when a hen reaches sexual maturity, a third type of nonstructural bone, medullary bone, is formed (Whitehead and Fleming, 2000). Medullary bone persists throughout the laying period and its formation is concomitant with maturation of the ovarian follicles (Dacke et al., 1999). It is argued (Whitehead and Fleming, 2000) that the conventional view that medullary bone contributes little to overall bone strength may not be totally correct. Fleming et al. (1998a) demonstrated that the presence of large amounts of medullary bone in the humerus of hens during the laying period improves bone strength. Medullary bone supplies calcium for eggshell formation at periods when dietary supply is not sufficient (Klasing, 1998). The two bones that are rich in medullary bone are femur and tibiotarsus.

Modern laying hens have a high susceptibility to bone fracture. The high incidence of fractures in live birds, which can occur both during the egg production period and in the course of depopulation and subsequent transport and handling, represents a severe welfare problem (Fleming et al., 1994). Although the growth performance of the modern broiler has changed considerably over recent years, their diets have changed little. It has been postulated that probably the porosity observed arises from the occurrence of more rapid bone modelling and remodelling in modern birds, together with an inadequate dietary supply of calcium and phosphorus.

The objective of this experiment was to determine the effects of three levels of calcium on the bone characteristics of broiler breeder hens during the laying period.

MATERIALS AND METHODS

One hundred and ninety eight Ross broiler breeder pullets were reared up to 22 weeks according to body mass guidelines on diets containing 1.0, 1.5 and 2.0% Ca. The pullets in each experimental diet were randomly divided into three treatment groups with 1.5, 2.5 and 3.5% dietary Ca (66 birds per treatment) fed from 23 to 60 weeks of age. A constant Ca : P ratio was maintained in all the diets (Table 2). The pullets were placed in individual cages, which were equipped with individual feed troughs, water nipples and perches. All data were collected on an individual bird basis and each bird was considered as an experimental unit.

Birds were first photostimulated at 154 days (22 weeks) in accordance with recommendation of Ross Breeders (2001). The photoperiod was extended with artificial light by 2 to 3 hours at 22 weeks and thereafter by one hour per week from 24 to 26 weeks of age when the birds received 16 hours of light. This was held constant until birds were depopulated at 60 weeks of age.

Experimental diets are given in Tables 1 and 2. Pullets were fed pre-breeder diet containing 1.0, 1.5 and 2.0% Ca from 19 to 22 weeks of age. Three types of breeder diets containing 1.5, 2.5 and 3.5% Ca were fed from 23 to 60 weeks of age (laying period) and these include: breeder phase 1 (23 to 34 weeks), breeder phase 2 (35 to 46 weeks) and breeder phase 3 (47 to 60 weeks). A diet with 2.5% Ca was obtained by mixing the 1.5% and 3.5% Ca diets. Each dietary treatment of the layer phase was fed to 66 replicates (22 birds per subgroup). Experimental diets were isocaloric and isonitrogenous. Feed was provided in restricted amounts in accordance with the breeders' recommendations, while water was provided *ad libitum*. Feed intake by individual birds was recorded on weekly basis and body weight was determined by weighing each bird at three weekly intervals. Mortality was recorded during the course of the experiment.

At 35 and 60 weeks of age, 12 birds were randomly selected from each treatment and killed by cervical dislocation. The carcasses were stored overnight in a refrigerator at 5 ^{o}C until the following day when the tibiae (left and right) and right humeri from each of the birds were excised and defleshed without boiling. The right tibiae and right humeri were then weighed and total length and bone shaft widths measured by means of a calliper with an accuracy of 0.001 cm (Zhang and Coon, 1997). The tibiae (both left and right) and right humeri were individually sealed in plastic bags to minimise moisture loss, and stored in a freezer at -18 ^{0}C for later analysis (Zhang and Coon, 1997). The bones were then removed from refrigerator for bone ash and breaking strength (BS) determinations. The right tibiae and right humeri were used for BS while left tibiae were used for bone ash determination and histomorphometric analysis. Breaking strength (N) was determined according to procedures described by Fleming et al. (1998b). Bone stress (N/mm^2), which is force per unit area of bone, was calculated by dividing bone strength with true cortical area (mm^2). True cortical area was calculated by multiplying cortical area with mean percent bone and divided by 100. Percent bone which is the reciprocal of porosity was determined from microscopic observations.

Left tibiae were dissected and a 5 mm ring from midshaft taken for histological processing. Two additional samples were taken, 20 mm on either side of the ring, and combined for ash measurements according to the procedures described by Fleming et al. (1998b) and Williams et al. (2000a). The bone cross-section taken for histology was fixed in 10% neutral buffered formalin, decalcified and processed for histomorphometric analysis according to procedures described by (Fleming et al., 1998b).

Data during the laying period (23 to 60 weeks) were analyzed as a 2 x 3 factorial block design (effect of 2 ages and 3 Ca levels) in which data from individual birds served as replicates. Data were subjected to ANOVA using the General Linear Models (GLM) procedure of SAS® (SAS Institute, 1996) (version 6.12) to assess the effect of dietary treatment on response variables relating to mechanical properties (bone strength and stress), bone dimensions (length, width and weight), bone chemical composition (ash percentage, Ca and P contents) and Ca intake. The differences between treatment means were separated using Tukey's studentised range test.

Table 1 - Physical composition of laying diets on air dry basis (%)

	Pre-breeder diet		Breeder Phase 1		Breeder Phase 2		Breeder Phase 3	
	1.5% Ca	3.5% Ca	1.5% Ca	3.5% Ca	1.5% Ca	3.5% Ca	1.5% Ca	3.5% Ca
Maize	63.54	63.51	61.92	59.66	63.11	60.81	56.43	62.23
Pollard Glutten	-	-	4.45	2.3	1.8	1.0	-	-
Wheat bran	12.65	6.65	5.15	-	6.55	-	14.90	1.00
Full fat soya	-	-	-	10.0	-	9.95	-	1.70
Soybean oil cake	7.75	11.4	8.6	10.3	8.4	7.55	8.75	9.50
Sunflower oil cake	12.45	11.1	15.0	7.75	15.0	10.00	15.00	15.0
Calcium carbonate (grit)	-	-	2.0	6.15	2.3	6.75	2.25	6.60
Calcium carbonate (fine)	1.15	2.2	0.5	1.5	0.6	1.65	0.6	1.65
Mono calcium phosphate	1.49	4.25	1.29	1.36	1.40	1.50	1.28	1.53
Salt	0.24	0.26	0.41	0.40	0.43	0.44	0.44	0.44
Bicarbonate	0.20	0.15	-	-	-	-	-	-
Choline liquid	0.04	0.04	0.03	0.03	-	0.03	-	-
Lysine	0.10	0.04	0.15	-	0.10		0.03	0.03
Methionine	0.05	0.05	0.005	0.06	0.01	0.05	0.01	0.02
Trace mineral / vitamin premix	0.35	0.35	0.50	0.50	0.30	0.30	0.30	0.30

Table 2 - Nutrient composition of experimental diets on air dry basis (%)

	Pre-breeder diet		Breeder phase 1		Breeder phase 2		Breeder phase 3	
	1.0% Ca	2.0% Ca	1.5% Ca	3.5% Ca	1.5% Ca	3.5% Ca	1.5% Ca	3.5% Ca
Moisture	11.07	10.37	10.58	9.96	9.77	9.10	9.85	9.19
Metabolisable Energy (MJ/kg)	11.96	11.70	12.09	12.00.	11.94	11.87	11.46	11.43
Protein	15.22	15.50	18.33	17.72	17.03	16.77	16.68	16.06
Crude fat	3.30	3.06	3.00	4.20	2.97	4.07	3.09	2.98
Crude fibre	7.01	5.99	0.00	0.00	6.65	5.08	8.28	6.64
Ash	0.00	0.00	6.21	11.23	6.74	12.05	6.90	11.98
Calcium	1.00	2.01	1.51	3.50	1.52	3.50	1.59	3.46
Phosphorus	0.84	1.37	0.78	0.71	0.80	0.74	0.84	0.78
Available phosphorus	0.45	0.90	0.41	0.40	0.43	0.43	0.43	0.54
Arginine	0.98	1.01	1.11	1.12	1.08	1.09	1.10	1.07
Isoleucine	0.60	0.64	0.74	0.76	0.69	0.71	0.67	0.67
Lysine			0.81	0.83	0.76	0.78	0.73	0.72
Methionine	0.35	0.34	0.38	0.38	0.35	0.36	0.33	0.33
TSAA[1]	0.06	0.64	0.73	0.70	0.68	0.67	0.66	0.64
Threonine	0.55	0.57	0.66	0.66	0.62	0.63	0.61	0.60
Tryptophan	0.17	0.18	0.19	0.20	0.18	0.19	0.19	0.18
TA[2] Arginine	0.91	0.93	1.04	1.04	0.99	1.01	1.01	0.99
TA[2] Isoleucine	0.54	0.57	0.67	0.69	0.62	0.65	0.59	0.60
TA[2] Lysine	0.60	0.60	0.70	0.71	0.64	0.67	0.61	0.61
TA[2] Methionine	0.31	0.31	0.34	0.35	0.31	0.33	0.29	0.30
TA[2] TSAA	0.57	0.57	0.64	0.63	0.59	0.60	0.57	0.56
TA[2] Threonine	0.48	0.50	0.59	0.59	0.55	0.56	0.26	0.53
TA[2] Tryptophan	0.15	0.16	0.17	0.18	0.17	0.17	0.17	0.17
AC:Linoleic acid	1.83	1.68	1.65	2.32	1.65	2.26	1.71	1.64
Xanthophylls	0.00	0.00	23.51	17.68	17.12	14.66	11.29	12.45
Salt	0.24	0.27	0.42	0.41	0.44	0.44	0.45	0.45
Choline	1300.01	1309.56	1205.18	1204.08	1008.79	1003.18	1087.10	993.06
Sodium	0.16	0.16	0.18	0.18	0.19	0.20	0.20	0.20
Chlorine	0.22	0.57	0.33	0.29	0.33	0.31	0.32	0.32
Potassium	0.60	0.60	0.60	0.63	0.63	0.63	0.71	0.61
Magnesium			0.22	0.20	0.23	0.21	0.25	0.23
Manganese			46.82	63.94	50.82	68.71	61.84	71.60

[1] Total sulphur amino acids. [2] Chemically determined

RESULTS AND DISCUSSION

Feed intake

The hens' feed intake was significantly (P<0.001) different among dietary treatments. Feed intake increased with increasing dietary Ca level with 1.5 and 3.5% Ca diets giving the lowest (989.62±4.72 g) and highest (1059.60±4.80 g) average feed intake values per hen for the total period, respectively. These results are in agreement with those of Clunies et al. (1992a) who fed three levels of Ca (2.5, 3.5 and 4.5%) to white Leghorn hens and found that birds fed 2.5% Ca diet had the lowest feed intake while those fed 3.5% Ca showed the highest. Summers et al. (1976) also reported similar differences by feeding laying hens on 1.5 and 2.96% Ca diets, respectively. Kornegay et al. (1985), Clunies and Leeson (1995) and Ahmad et al. (2003), however, reported no effect of dietary Ca level on feed consumption of hens fed on diets containing Ca levels ranging from 2.5 to 5.0%. Feed intake significantly (P<0.001) increased with age.

Calcium intake

Different intakes of Ca by the hens in each treatment were achieved by feeding the various Ca levels. Keshavarz and Nakajima (1993) and Clunies and Leeson (1995) reported a significant (P<0.05) increase in Ca intake by feeding dietary Ca levels ranging from 2.5 to 5.5%. Kemp and Kenny (2004) suggested that breeders need 4-5 grams of Ca per day from the first egg throughout the laying period. This requirement is satisfied by making the change from pre-breeder (1.5% Ca) to breeder (2.8% Ca) diets immediately prior to the first egg (Ross Breeders, 1998). The 2.5% dietary Ca levels in the current study appeared to provide the recommended requirements (4-5 g). On the other hand, the Ca intake by hens fed 3.5% dietary Ca exceeds the proposed intake.

Daily Ca intake increased with age except for weeks 38 and 58. The variation in Ca intake at especially weeks 38 and 58 could be attributable to high and low temperatures. The maximum and minimum temperatures at week 38 were 35.6 °C and 17 °C, respectively. At week 58, maximum and minimum temperatures of 19.4 °C and 4.0 °C were recorded.

Body weight

Hen BW increased (P<0.05) as dietary Ca concentration increased from 1.5 to 3.5%. Birds fed 1.5% Ca diet had significantly (P<0.05) lower BW than those fed 2.5 and 3.5% Ca diets, respectively. However, BW for birds fed 2.5% and 3.5% Ca diets was not significantly different, indicating that either of these two levels is sufficient to support growth. The results of this study support those of Clunies and Leeson (1995) and Menge et al. (1977) who reported improved BW in laying Single Comb White Leghorn hens and turkey hens fed increasing dietary Ca levels ranging from 1.16 to 5.5%. A significant (P<0.001) Ca level x age interaction occurred.

Mortality

Twelve birds died (4 from each treatment) during the laying period representing a cumulative mortality rate of 6%. This indicates that treatment did not influence mortality in agreement with Atkinson et al. (1967).

Bone dimensions

As illustrated in Table 3, bone length, width and weight were not significantly (P>.05) influenced by dietary Ca level. The results of the current study are inconsistent with Williams et al. (2000b), who reported that the tibiotarsus width of broilers fed higher levels of Ca decreased linearly with increasing dietary Ca content. These workers suggested that the small dietary Ca effects on body weight and bone ash could have combined to give a stronger, but indirect, effect on bone width. However, the results of the present study do not support these findings. In contrast with the humerus, the length and width of tibia significantly (P<0.001) increased and decreased with age, respectively. No explanation could be given for this.

From Table 3 it is apparent that bone weight did not change significantly (P>.05) with age. The gradual resorption of medullary bone for eggshell formation during the laying period could have contributed to this non-significant bone weight result. Although it is generally thought that medullary bone has non-structural properties, Fleming et al. (1996) have shown that it contributes to overall bone strength. Resorption of medullary bone could result in weaker bones.

Bone mechanical properties

Measurements of breaking strengths of humeri and tibiae are given in Table 3. It seems that bone strength (BS) significantly (P<0.02) increased with increased levels of dietary Ca. Although the BS for birds fed 2.5 and 3.5%

Ca diets was not statistically different, birds on 3.5% Ca diet tended to have numerically greater BS values. These results are in agreement with those of Rowland et al. (1968) who reported significantly (P<0.05) higher BS for birds fed 6.8% Ca diets compared to 1.0%. In contrast to these results, Moore et al. (1977) observed no statistical differences in the BS of radii of 4 months old commercial layer hens fed 3.78% Ca and 1.0% P and 3.22% Ca and 0.65% P diets.

Table 3 - The effect of calcium level and age on bone dimensions and mechanical properties of bones in broiler breeder hens

		Age (weeks)			Significance of effect (P)			
	Treatment	35	60	Means	Treatment	Age	Interaction	CV
Right tibia								
Length (mm)	1.5% Ca	124.36 ± 1.11	128.87 ± 1.16	126.62 ± 0.80ᵃ	0.3220	0.0004	0.5903	3.1
	2.5% Ca	124.23 ± 1.11	126.44 ± 1.11	125.33 ± 0.79ᵃ				
	3.5% Ca	123.19 ± 1.11	126.79 ± 1.11	124.99 ± 0.79ᵃ				
	Means	123.93 ± 0.64	127.37 ± 0.65					
Width (mm)	1.5% Ca	7.87 ± 1.89	7.24 ± 0.20	7.55 ± 0.14ᵃ	0.8833	0.0001	0.4287	8.6
	2.5% Ca	7.90 ± 1.89	7.39 ± 0.19	7.65 ± 0.13ᵃ				
	3.5% Ca	8.10 ± 1.89	7.12 ± 0.19	7.61 ± 0.13ᵃ				
	Means	7.96 ± 0.11ᵃ	7.25 ± 0.11ᵇ					
Weight (g)	1.5% Ca	17.81 ± 0.54	18.60 ± 0.56	18.21 ± 0.39ᵃ	0.2059	0.9566	0.3813	10.0
	2.5% Ca	18.75 ± 0.54	18.77 ± 0.54	18.76 ± 0.38ᵃ				
	3.5% Ca	19.55 ± 0.54	18.82 ± 0.54	19.19 ± 0.38ᵃ				
	Means	18.71 ± 0.31ᵃ	18.73 ± 0.32ᵃ					
Bone strength (N)	1.5% Ca	235.00 ± 68.74	252.00 ± 93.43	242.20 ±15.56ᵃ	0.0001	0.9809	0.7308	23.3
	2.5% Ca	320.42 ± 56.18	315.00 ± 58.54	317.71 ± 14.44ᵇ				
	3.5% Ca	350.00 ± 54.10	340.00 ± 105.45	343.50 ± 14.79ᵇ				
	Means	300.93 ± 12.00ᵃ	301.34 ± 12.38ᵃ					
Bone stress (N/mm^2)	1.5% Ca	27.90 ± 5.47	19.33 ± 6.86	23.61 ± 4.39ᵃ	0.5893	0.0081	0.7790	68.5
	2.5% Ca	32.63 ± 5.47	16.50 ± 6.42	24.57 ± 4.22ᵃ				
	3.5% Ca	37.39 ± 6.05	21.38 ± 5.74	29.38 ± 4.17ᵃ				
	Means	32.33 ± 3.27ᵃ	19.07 ± 3.67ᵇ					
Right humerus								
Length (mm)	1.5% Ca	84.09 ± 1.55	81.99 ± 1.62	83.04 ± 1.22ᵃ	0.7338	0.7061	0.6245	6.4
	2.5% Ca	82.94 ± 1.55	83.88 ± 1.55	83.41 ± 1.10ᵃ				
	3.5% Ca	84.39 ± 1.55	84.10 ± 1.55	84.25 ± 1.10ᵃ				
	Means	83.81 ± 0.90ᵃ	83.32 ± 0.91ᵃ					
Width (mm)	1.5% Ca	6.53 ± 0.11	6.50 ± 0.12	6.51 ± 0.80ᵃ	0.8781	0.4454	0.7765	6.1
	2.5% Ca	6.56 ± 0.11	6.39 ± 0.11	6.48 ± 0.80ᵃ				
	3.5% Ca	6.47 ± 0.11	6.44 ± 0.11	6.45 ± 0.80ᵃ				
	Means	6.52 ± 0.07ᵃ	6.44 ± 0.07ᵃ					
Weight (g)	1.5% Ca	10.28 ± 0.74	9.83 ± 0.77	10.05 ± 0.53ᵃ	0.0927	0.5169	0.4503	26.0
	2.5% Ca	8.77 ± 0.74	9.00 ± 0.74	8.89 ± 0.52ᵃ				
	3.5% Ca	9.76 ± 0.74	11.16 ± 0.74	10.46 ± 0.52ᵃ				
	Means	9.60 ± 0.42ᵃ	10.00 ± 0.43ᵃ					
Bone strength (N)	1.5% Ca	235.00 ± 22.38	252.00 ± 23.47	243.50 ± 16.22ᵇ	0.0001	0.9768	0.8149	24.4
	2.5% Ca	320.42 ± 21.43	315.00 ± 21.43	317.71 ± 15.15ᵃ				
	3.5% Ca	350.00 ± 21.43	340.00 ± 22.38	345.00 ± 15.49ᵃ				
	Means	301.81 ± 12.56ᵃ	302.33 ± 1.96ᵃ					

Means with the same letter within a column (treatment) or row (age) are not significantly different for the same variable

Stress values were not significantly (P>0.05) different for any treatment, suggesting that mineralisation was similar across treatment groups. Although it was apparent from Table 3 that dietary Ca did not influence bone stress, birds fed 3.5% Ca tended to have higher stress values compared to those fed 1.5% and 2.5% Ca diets. The high coefficient of variation could have contributed to these non-significant results. Previous studies (Whitehead and Wilson, 1992) have shown that there is a constant decline in structural bone content of hens throughout the laying period. Whitehead (2004) states that the general net effect of the replacement of structural bone is to weaken the overall strength of the hen's skeleton and thus increase fracture. In the current study, no significant (P=0.98) influence of age on BS occurred. It is, however, evident from Table 3 that bone stress significantly (P<0.0081) decreased with age indicating that the degree of mineralisation of bone was greater at 35 weeks compared to 60 weeks. Bone stress decreased by approximately 46% between 35 and 60 weeks of age. This indicates progressive loss of structural bone over the life of the laying hen and its subsequent replacement with medullary bone. Crenshaw et al. (1981) stated that as bone mineralisation increases, maximum stress and bending moment of the bone increase. At a point of optimum mineralisation, stress reaches a maximum. Conversely, the lower stress indicates that the hens had bones that were less mineralised.

Bone chemical composition

Data on bone ash, Ca and P content of bone ash are given in Table 4. There were no significant (P>0.05) differences in tibia ash among dietary Ca levels. These results are in disagreement with those of Atteh and Leeson (1983) who reported a significantly (P<0.05) higher bone ash content with increasing dietary Ca from 3.0 to 4.2%. In disagreement with Rowland et al. (1968, 1972), tibia ash did not appear to be related to BS in the current study. These workers reported that caged hens that had low BS had significantly lower tibia ash values than floor hens.

No significant (P<0.05) differences were observed between the two age periods with respect to tibia ash content. In the present study, average tibia ash content at 35 and 60 weeks was 55.2 and 54.8%, respectively (Table 4). Newman and Leeson (1999) suggested that low ash values probably indicate that medullary bone was being resorbed at a faster rate in order to supply sufficient Ca to maintain shell formation. Whitehead (2004) suggested that the considerable rise in circulating oestrogen at the onset of hen's sexual maturity has a stimulatory effect on osteoblasts, causing them to produce medullary bone instead of structural bone. In the absence of structural bone formation, continued osteoclastic resorption would be expected to give rise to a net depletion of structural bone, leading ultimately to osteoporosis (Fleming et al. 1998b). The decline (P<0.001) in Ca content observed from 35 to 60 weeks of age in the current study support the view that the medullary bone was being resorbed to support shell formation resulting in bones with lower bone stress values. These results were, however, not supported by the ash values of bones (Table 4).

Table 4 - The effect of calcium level and age on bone composition of broiler breeder hens

		Age (weeks)			Significance of effect (P)			
	Treatment	35	60	Means	Treatment	Age	Interaction	CV
Left tibia								
Ash content, %	1.5% Ca	56.82 ± 3.24	52.39 ± 7.33	54.61 ± 1.04[a]	0.1080	0.7504	0.0661	9.3
	2.5% Ca	52.74 ± 3.26	54.66 ± 7.11	53.70 ± 1.04[a]				
	3.5% Ca	56.10 ± 4.65	57.47 ± 3.66	56.78 ± 1.04[a]				
	Means	55.22[a]	54.84[a]					
Calcium, %	1.5% Ca	38.22 ± 0.96	14.33 ± 0.92	26.28 ± 0.67[a]	0.7197	0.0001	0.2439	12.2
	2.5% Ca	39.63 ± 0.92	13.73 ± 0.92	26.68± 0.65[a]				
	3.5% Ca	37.33 ± 0.92	14.52 ± 0.92	25.93 ± 0.65[a]				
	Means	38.89 ± 0.54[a]	14.19 ± 0.53[b]					
Phosphorus, %	1.0% Ca	16.87 ± 0.34	6.61 ± 0.33	11.74 ± 0.24[b]	0.0415	0.0001	0.9244	10.2
	1.5% Ca	16.29 ± 0.33	5.92 ± 0.33	11.11 ± 0.23[ab]				
	2.0% Ca	15.98 ± 0.33	5.89 ± 0.33	10.92 ± 0.23[a]				
	Means	16.38 ± 0.19[a]	6.13 ± 0.19[b]					
TCA[1] (mm^2)	1.0% Ca	13.64 ± 1.45	14.14 ± 1.45	13.89 ± 0.99[a]	0.0856	0.0987	0.5925	24.5
	1.5% Ca	15.24 ± 0.99	16.84 ± 1.36	16.04 ± 0.84[a]				
	2.0% Ca	15.25 ± 1.28	18.43 ± 1.21	16.84 ± 0.88[a]				
	Means	14.71 ± 0.72[a]	16.47 ± 0.76[a]					
Percent bone	1.5% Ca	0.82 ± 0.07	0.91 ± 0.06	0.86 ± 0.05[a]	0.9116	0.0209	0.8706	20.6
	2.5% Ca	0.82 ± 0.04	0.92 ± 0.06	0.87 ± 0.04[a]				
	3.5% Ca	0.77 ± 0.06	0.92 ± 0.06	0.85 ± 0.04[a]				
	Means	0.81 ± 0.03[a]	0.92 ± 0.03[a]					

[1]TCA – true cortical area (cortical area multiplied by mean % bone divided by 100). Means with the same letter within a column (treatment) or row (age) are not significantly different for the same variable.

The percentage of Ca present in the mineral component of the tibia was not significantly (P=0.72) different between Ca levels (Table 4). The mean values for 1.5, 2.5 and 3.5% Ca levels are 26.28, 26.68 and 25.93%, respectively. Clunies et al. (1992b) suggested that perhaps with higher levels of dietary Ca there is a decreased dependence upon medullary bone mineral to supply Ca for shell formation. The results of the current study do not seem to support this view given the low mean Ca content of bone ash for birds on 3.5% Ca diets. According to Hurwitz and Barr (1966), medullary bone Ca increases with increasing dietary Ca levels. The results of the present study are consistent with those of Clunies and Leeson (1995) and Keshavarz and Nakajima (1993), who found no beneficial effects of feeding increased dietary Ca levels (2.5 to 5.5% Ca) on bone Ca levels of laying hens.

In the present study, birds fed 3.5% Ca diet had significantly ($P<0.05$) lower P content compared to those fed 1.5% Ca diets. No explanation could be given for this. Phosphorus content of the bone tended to decline with increasing dietary Ca level.

During the test period (35 to 60 weeks) both Ca and P content of bone ash significantly ($P<0.001$) declined by 63.5 and 62.6%, respectively. This represents a monthly decline of 2.1 % for both parameters. The decline in Ca content of bone is expected, as the hen requires Ca for eggshell formation during the laying period. It is well documented that egg weight and size increase with age, indicating that the heavier egg requires more calcium to be deposited as shell than a lighter egg. Most of the calcium required for eggshell formation is obtained from the medullary bone, which is continuously resorbed during the laying period resulting in low Ca in the bones.

True cortical area and percent bone

According to Table 4, true cortical area (TCA) and percent bone were not statistically influenced by dietary Ca level. Percent bone significantly ($P<0.02$) increased with age and TCA did not.

CONCLUSIONS

The present results demonstrated no beneficial effects of feeding increased Ca levels on all bone parameters except BS. The feed intake and body weight of broiler breeder hens were; however, lower when 1.5% Ca was included in the diet. Therefore, it seems that 2.5% Ca (4 g Ca/hen/day) is adequate to stimulate feed intake and support growth of broiler breeder hens. This level will also supply the requirements for bone development and Ca content. Bone stress decreased with age, indicating that the degree of bone mineralisation was greater at 35 weeks compared to 60 weeks.

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