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Ostrich Feeding and Nutrition

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Abstract: Ostriches are monogastric herbivores. Palatability is crucial to stimulate feed ingestion by the birds. When formulating rations for ostriches, cotton seed cake, meal or seeds should not be used to avoid gossypol poisoning. Salt in mixed ration should not exceed 0.5% of the ration. Fresh, clean water must be available for the birds free choice. The water economy of the ostrich is similar to that of other large savannah and desert animals such as antelope and camel, although the partitioning of water loss differs. The ratio of water intake to dry matter intake is relatively constant at about 2.3. The diet composition of the ostrich is similar to that of grant's gazelle on the ranges, however differ in that the birds eat some silica-rich plants which are not utilized by ungulates. Ostriches may therefore be considered useful addition to mixed species game ranching.

Key words: Ostrich diet, feeding behaviour, feed digestion

Introduction

The natural diet of ostriches is mainly green grasses, berries, seeds, succulent plants and small insects. The adult ostrich on pasture eats three times as much dry matter in relation to the diary cow when expressed as a percentage of body weight (7.5% vs 2.5%). When practicing a system of alternative grazing, the carrying capacity lucern pastures is 8 ostriches per hectare. Cost of feeding is the largest expenditure in ostrich farming. A well conditioned chick with optimum growth rate; and well nourished is less likely to succumb to diseases. Nutrition plays vital role in ostrich production. Ostriches have very efficient feed conversions during the first 210 days of their life. After 330 days they become inefficient and their feed conversion drops. Therefore, it is important that chicks are fed optimally when young so that they attain the ideal slaughter weight of 90-100kg as quickly as possible.

Chicks learn to eat under natural wild condition by copying their parents feeding behaviour. Therefore; under commercial artificial production system, a surrogate mother or an older chick should be used to teach the young chicks how to eat. Chicks depend on their yolk sac for the bulk of their nutrition in the first 10 to 14 days of life. They should therefore be eating well by the time the yolk sac is finished so that the chicks maintain normal growth and development. Grit and feed should be offered to the young chicks. Concentrate offered to the chicks should contain 20% by weight of green forage as the green colour stimulates pecking. Shallow troughs or trays should be used to offer chicks their feed. Palatability of the feed is enhanced when it is dampened. Ostrich feeds can be pelleted or in meal form. When feed is offered as meals, it reduces cost since pelleting costs are high. Birds spend more time pecking at the meals and therefore, develop fewer behavioural disorders. Farm mixed feeds cannot readily be pelleted hence, molasses or stabilized fat can be added to reduce dustiness and increase palatability. Pellets are easier to be used as feed. This results in less wastage, minimal dustiness and less separation of feed ingredients. This is however more expensive than the use of meals.

The day - old - ostrich chicks up to 13 weeks of age may be fed on chick starter which is high in crude protein (Table 1). From 13 weeks to 40 weeks, the feed should be switched to grower. From 40 weeks to slaughter, the ostriches should be fed on maintenance diet. Alternatively, the ostriches may be fed maintenance diet from 15 weeks of age to slaughter depending on the body condition of the birds and marketing plans. Table 2 shows possible feed compositions and ingredients (Table 3) used in formulating rations for ostriches.

Common feed ingredients used are maize - meal as a source of concentrated energy while alfalfa (lucern) serves as a source of bulk, fibre and protein. Fish meal and peanut meal are sources of crude protein and lipid especially the essential fatty acids (linoleic and linolenic acids). Carcass meal is also a source of protein and amino acids which are important for the growth of the ostriches. Methionine and Lysine are essential amino acids usually included in poultry diets since these amino acids are limiting in most feed ingredients. Vitamin/mineral premixes are included in the rations as sources of vitamins and minerals especially the trace minerals. Limestone is a source of calcium while monocalcium phosphate supplies calcium and phosphorus.

Palatability is crucial to stimulate feed ingestion by the birds. Thus, it is given important consideration in ration

Table 1: Composition and calculated analysis (air dry basis) in g/kg of ostrich diets at various stages

Ingredient	1 to 6 weeks	3 to 13 weeks	13 to 40 weeks	Maintenance
Maize meal	600.0	520.0	550.0	550.0
Fish meal	100.0	65.0	16.3	0.0
Peanut oil cake	200.0	130.0	32.5	0.0
Carcass meal	0.0	30.0	15.0	10.0
Alfalfa	60.0	260.0	370.0	410.0
Lysine HCl	2.5	1.63	0.41	0.0
Methionine	2.0	1.22	0.31	0.0
Vit/min premix	2.5	1.22	0.41	1.0
Monocalcium phosphate	13.68	1.7	13.3	17.0
Limestone	10.6	0.00	5.0	8.0
Fine salt	1.5	2.0	2.2	2.3
ME MJ/kg	12.23	10.77	9.67	9.17
Protein %	21.5	20.1	13.9	11.8
Lysine %	1.12	0.99	0.62	0.5
Calcium %	1.15	0.96	1.14	1.25
Avail. Phos %	0.64	0.46	0.48	0.49

Source: Aganga *et al.*, 2000.

Table 2: Possible Feeds composition

	Starter	Grower	Maintenance	Breeder
Protein	17-20	15-17	12-14	12-14
Fat (%)	2.5	2.5	2.5	2.5
Fibre (%)	13.5	17.5	16.25	17.5
Calcium	1.2-1.5	1.0-1.6	0.9-1.4	2.0-3.5
Phosphorus	0.5-0.7	0.5-0..65	0.6	0.6-0.65
ME (Mj/kg) Poultry	11-12	9-10	8-10	8-10
Moisture	12	12	12	12
Lysine	1.0	0.75	0.60	0.60
Arginine	1.20	0.86	0.46	0.76
Tryptophan	0.24	0.19	0.16	0.21
Isoleucine	0.77-0.87	0.56-0.62	0.38	0.57
Threonine	0.73	0.59	0.41	0.57
Histidine	0.50	0.37	0.21	0.31
Methionine	0.3-0.4	0.3-3.5	0.19-0.25	0.27
Potassium	0.74	0.77	0.98	0.87
Magnesium	0.29	0.29	0.24	0.25
Salt	0.5	0.5	0.5	0.5

Table 3: some ingredients used to formulate ostrich feeds

Protein	Fibre source	Energy source	Mineral
Carcass meal	Lucern meal	Maize Meal	Monocalcium phosphate
Sunflower seeds	Sunflower	Sorghum	Limestone
Sunflower meal	Hominy chops	Molasses	Oyster shells
Fish meal	Wheat bran	Barley	
Soybean meal		Wheat	

Source: Johnson (1999)

formulation. Dehydrated molasses powder improves feed palatability. It is necessary to add vitamin premix to the rations and amino acids in order to meet the birds requirements. Cotton seed cake, meal or seeds should not be mixed into ostrich ration to avoid gossypol poisoning. Cotton seed and products contain gossypol which is an anti-nutritional factor. Salt in mixed ration should not exceed 0.5% of the ration.

Salt composed of Na and Cl is required for electrolyte balance in the birds. It is also serves as a condiment to stimulate feed intake. Fresh, clean water must be available for the birds free choice. Access to potable

Table 4: Trace Element And Vitamin Supplementation In Total Diet For Ostriches*

Ingredient	Unit	Grower Diets (/1000kg)	Grower and Finisher Diets (/1000 kg)	Layer Diets (/1000kg)
Vit A	IU	12 000 000	9 000 000	15 000 000
Vit D_3	IU	3 000 000	2 000 000	2 500 000
Vit E	IU	40 000	10 000	30 000
Vit K_3	g	3	2	3
Vit B_1	g	3	1	2
Vit B_2	g	8	5	8
Niacin	g	60	60	45
Calc.Pantha	g	14	8	18
Vit B_{12}	mg	100	10	100
Vit B_6	g	4	3	4
Choline Cloride	g	500	150	500
Folic Acid	g	2	1	1
Biotin	mg	200	10	100
Endox R1	g	100	-	100
Magnesium	g	50	-	40
Manganese	g	120	80	120
Zinc	g	80	50	90
Copper	g	15	15	15
Iodine	g	0.5	1	1
Cobalt	g	0.1	0.3	0.1
Iron	g	35	20	35
Selenium	g	0.3	0.15	0.3

* Degen *et al.,* 1991

water has a direct relationship with feed intake. Generally, poultry require 2 grams of water for every 1 gram of dry feed intake. The water economy of the ostrich is similar to that of other large savannah and desert animals such as antelope and camel, although the partitioning of water loss differs. The ostrich has a lower evaporative water loss and a higher faecal and urinary loss than mammals of similar bodyweight. The ratio of water intake to dry matter intake is relatively constant at about 2.3 (Degen *et al.*,1991).

Feeding Behaviour of Ostriches: Ostriches spend 70 to 80% of daylight hours feeding with continuous ingestion and movement being important in their digestive physiology. In the wild, the diet consists of 60% plant material, 15% fruits and legumes, 4 or 5% insect eggs and small mammals, the rest consisting of cereal grain, salts and stones. Feed should be made continuously available to the ostriches rather than fed as meals. The dietary selection of juvenile ostriches in an East African savanna was determined using penned and free ranging chicks by Cooper and Palmer (1994). They observed that young ostriches displayed an innate preference and showed little change in diet composition with increasing experience. The most heavily utilized foods were newly emergent grass leaves and the foliage of the woody forbs *Indigofera schimperi* (leguminosae) and forbs *Aspilia mossambicensis* (compositae). They observed that the diet composition of the ostrich is similar to that of grant's gazelle.

Ostriches however differ in that they eat some silica - rich plants which are not utilized by ungulates. Ostriches may therefore be considered useful addition to mixed species game ranching in Africa. The time - activity budget of eight, 5-6 month - old growing ostrich that were offered only concentrate feed and were maintained on packed ground in 4 out-door pens (3x6 each) was studied by Degen *et al.* (1989). They observed that the ostriches were active for about 12 hours during the day. They spent about 20.4% of the 12 hour active day sitting, about 5.5% standing, 6.6% eating concentrate feed, 5.0% foraging (pecking the ground) and about 1.1% drinking. They observed that each pair of ostriches usually behaved in synchrony. Sitting was reported mostly done with their necks straight up and their legs folded under their bodies, and on occasion with their necks and heads prone on the ground. Most time spent walking was with their necks straight up and sometimes with their heads in an s-shape more or less parallel or close to the ground. They usually walked at a rate of about 1m/s along the edges of their pens. They found that each ostrich ate about 1911 g DM feed/day and spent 46.4 minutes eating and pecked at their feed about 2830 times and thus; they ate about 41.2 g DM/min feeding and 0.7g DM/peck. They also consumed 129.2 g DM of earth, spent 35.3 min/day foraging and

pecked at the ground 1957 times/day. Furthermore, it was estimated that about 1.0 litre/day of preformed and metabolic water were obtained from feed and 9.1 litre/day from drinking. They spent 8.2 min/day drinking, during which time they took about 315 sips. Milton *et al.* (1993) stated that captive ostrich Struthio Camelus chicks, 3-9 weeks of age, on a diet of pelleted feed and fresh lucern, consumed 55% (434) of 78 harvester termite Microhodotermes viator offered to them. Milton *et al.* (1993) thus, suggested that, although adult ostriches are herbivorous, young chicks may benefit by supplementing their diet with insect protein.

Sambraus (1995) reported behavioural disorders in the food intake of ostriches. The most striking behaviour disorder was feather pecking. However, the animals showed four other behaviour patterns, which almost must be qualified as behaviour disorders: pecking sand, pecking wire, pecking their own feathers and pecking into air, occurred in a random succession. Sambraus (1995) concluded that the behavioural disorders is a result of the nutrition, which differs from the natural feeding situation, as the animals were fed exclusively on pellets so that food consumption is completed within a very short time. This was observed to result in an accumulation of action specific energy within the functional circle of nutrition. He suggested that food of ostriches should be of a consistency which guarantees food intake of appropriate satisfactory duration. Samson (1996) reported behavioural problems of farmed ostriches in Canada during extreme confinement in the winter months. The ostriches of all age groups perform abnormal behaviours like feather-picking, pica, anorexia, dietary indiscretion, behavioural stargazing, a dypsia and aggression. These abnormal behaviours were reported to be initiated by inadequate husbandry techniques, eventually become medical problems because of the severity.

Feed Digestion: The digestive system of the ostrich is that of a simple stomached (monogastric) herbivore which has the ability to utilize forage. Adult ostrich is a hind gut fermented like the donkey, horse or rabbit. Therefore, it is essential that their intestines are inhabited with useful bacteria as early as possible. The gastro-intestinal track (GIT) starts from the mouth in which the teeth are replaced by a beak. The mouth empties to the upper part of the oesophagus which is pouch-like that allows the accumulation of feed when consumed. The swallowed feed moves visibly down the gullet when swallowed and empties directly into the glandular stomach (proventriculus); where digestive enzymes and acids are secreted. The glandular stomach leads into the gizzard which usually contains grits. These grits are used to grind the feed into smaller particles which the digestive enzymes can the digest. The grits are usually worn down, gradually and are never excreted whole. The stones offered to ostrich chicks should be round in shape and not angular stones to prevent damage of the GIT by the sharp ends. These stones should be made of strong material such as quartz and not substances that easily dissolve like oyster shell, limestone grit or dolomite.

The gizzard empties the ingesta into the small intestine which is relatively short and leads into the colon. Two large caeca protrude from the end of the small intestine. The colon is very long and may be longer than 10 metres in the adult bird. Microbial fermentation takes place in the hind-gut which leads to the formation of volatile fatty acids which are absorbed and metabolized as an energy source. The ostrich is capable of digesting fibrous feedstuffs such as cellulose and hemicellulose. Swart *et al.* (1993a) studied fermentative digestion in the ostrich using radioactive substrates to confirm that the products derived from fermentative digestion could provide nutrients to the host animals. The results showed that theoretically, energy contribution of volatile fatty acids (VFA) could be as high as 76% of the metabolizable energy requirements of the growing ostrich.

Energy metabolism and digestion of dietary fibre in growing ostrich chicks were studied at different live masses (5-50kg) by means of a total excreta collection method and a radioactive indicator method by Swart *et al.* (1993b). They found that passage rate within live mass groups varied considerably (from 21 to 76h). Overall mean passage rate was 40.1 h and it was independent of live mass. Digestibility coefficients for cell wall (NDF), hemicellulose and cellulose were 47, 66 and 38% respectively, and were not influenced by live mass. They found that the hindgut provided a suitable nutritional environment for fermentative micro flora, especially in the enlarged haustrated colon of the ostrich, also they found that of the total metabolizable energy in the diet, 12% disappeared in the hindgut. Swart *et al.* (1993c) found that energy loss as methane was negligible and was influenced by dietary energy or crude fibre concentration. They found that maintenance energy (ME) requirement was 0.44 MJ/metabolic size/day and the efficiency of ME utilization tended to deteriorate with decreasing energy or increasing crude fibre concentration in the diet.

Nutrient requirements: Ostriches are able to make better use of energy locked up in forages than poultry. The digestibility of apparent Metabolizable Energy (ME), fat and neutral detergent fibre (NDF) increases with age in ostrich chicks and plateau at about 17 weeks of age. Since ostriches are not typical poultry but monogastric herbivore, the ME values are 41% higher than that of poultry. Cilliers *et al.* (1994) evaluated the apparent metabolizable energy (ME) values corrected for zero nitrogen retention [AME (n)] in ostriches by balance

method for maize and lucern meal. The ostrich basal diet in the study consisted of 1000g/kg lucern, and was blended in the ratio 50 lurerne: 50 maize and 25 lucern: 75 maize. Each dietary treatment was given to five ostriches, individually housed in metabolism crates. For the ostriches a value of 8.9 MJ/KG was found for lucern. True ME , corrected for zero nitrogen retention, [TME(n)] was computed by regressing gross energy output on gross energy input over all feeding levels. Maize yielded values of 14.9 and lucern values was 8.6 MJ/kg. They compared ostriches with roosters and concluded that the ostriches were capable of digesting a high starch diet such as adult roosters but ostriches were capable of digesting a high fibre ingredient such as lucern meal much more efficiently. Degen *et al.* (1991) reported that maintenance energy requirements were 1.07 MJ/kg, 0.63 daily and energy requirements for kg body mass increase were 0.260 MJ/kg 1.09. Gandini *et al.* (1986) worked with twenty ostrich (Struthio Camelus) chicks up to 8 weeks of age which were fed on isocaloric diets containing protein at 14, 16, 18 and 20%. The highest mean body weight gain was obtained from the 20% - protein diet; however, this result was not significantly different. Feed conversion favoured the 18% - protein group. They observed that during the 7^{th} and 8^{th} week of the experimental period some chicks developed leg deformities. Clinical signs, radiological findings and responses to calcium supplementation suggested an insufficient amount of calcium in the experimental diets. Dietary habits in the wild and gastrointestinal anatomy and function have established that the ostrich is an herbivore. Ullrey and Allen (1996) emphasized that ostriches are not turkeys, but turkeys may be the best avian model we have from which to predict the ostrich's nutrient needs. They suggested that in order to minimize leg abnormalities in ostrich chicks, it may be helpful to restrict weight gain by limiting dietary protein concentrations below those recommended for starting turkeys and by using higher fibre diets. Non-slip surfaces and exercise also are very important. They also reported that egg production by ostriches laying a normal annual clutch does not significantly increase the dietary calcium requirements. They observed that when egg production is forced by continually removing eggs, calcium requirements should be met by dietary concentration of 16g/kg.

Alternatively, *ad libitum* access to granulated calcium carbonate or oyster shell could be provided. Vitamin A should be supplemented in the diet of growing chicks especially chicks which have no green grazing. Vitamin E is vital in ostrich production as it is a biological antioxidant and helps increase immunity. Vit B is synthesized by the micro flora in the hind - gut of the ostrich therefore growing ostriches fed on lucern and supplemented as a safe - guard against deficiencies and to improve the immune system. Calcium levels of 2 to 2.5% in layer diets are recommended, but levels of 1.65% of dry matter in the diet led to excellent laying and fertility of eggs. High calcium level lead to depressed uptake of zinc and manganese. Manganese deficiency leads to deformed leg syndrome and porosis.

Table 4 shows trace elements and vitamin supplementation in total diets for ostriches.

Swart and Kemm (1985) studied 9 groups of 6 ostriches, male or female, feedlots from 250 to 462 days old. They were fed on meal diets of lucern, maize, ostrich carcass meal and mineral with 14, 16 or 18% protein combined with 3 different roughage: concentrate ratios. From 60 to 110 kg live weight, daily weight gain and feed conversion ratio in the groups ranged from 129 to 240g and from 10.0 to 15.4, averages 189g and 12.8, compared with 179g and 14.8 for control ostriches on a conventional farm diet of lucern 70 and maize 30%, with 14% protein. Overall mean mass of plucked body feather was 707g; differences among groups for feather yield or quality were not significant ($P>0.05$).

Water Requirement: Ostriches require 2.3 grams of water for every/gram of dry feed intake. The production of white urine by ostriches can be indicative of illness or water deprivation. A metabolic renal study was carried out by dehydrating young healthy ostriches for 2 days, the period during which urine was still excreted (Levy *et al.*, 1990). It was found that the normally copious colourless urine changed to a thick, white excretion after 2 days' dehydration and no fluids was excreted after 3 days. From blood and urine analyses, it was concluded that the ostrich conserves body water by an excellent renal concentrating mechanism which excretes urates. This excretion is a useful sign to the farmer on the state of health of the bird.

Ostriches can survive long periods in the wild without water by drinking cumulatively large quantities when it is available. Restriction of water under artificial, intensive rearing system leads to a decrease in dry feed intake. Therefore, water should be provided *ad libitum* during day light hours. Water troughs should be kept in the shades in the paddock to keep the water cool as ostriches will avoid drinking excessively warm water. Metallic proventricular foreign bodies are a potential source of heavy metal poisoning in ratites. Cases of iro and zinc, poisoning in ostriches were reported by Edwards *et al.* (1992). Rae (1992) observed that a large percentage of young ratites submitted for necropsy exhibited evidence of degenerative myopathy. The species examined included the ostrich (struthio camelus), the rhea (Rhea Americana) and the emu (Dromiceius novaehollandiae). The vast majority of the birds examined were six months of age or younger. Lesions of acute myocardial and skeletal muscle degeneration were observed. Histologic lesions were indistinguishable from the nutritional myopathy

Table 5: Common Nutritional Disorders

Nutrients	specified deficiency symptoms	Treatment
Vitamin E and Selenium	Egg dead in shell Weak hatch Sudden death (Downer ostrich) Nervous symptom Permanent sterility in males may result from prolonged deficiency	Supplementation of vitamin E and selenium in the diet A special supplement known as Hamish Cameron Vitamin E/Selenium ostrich supplement can be added each day to the feed at 1g/kg. This supplement contains 40 000 IU Vitamin E and 40 mg selenium per kg Injection of vitamin E and selenium (Injacom E - Roche) at a dose of 0.25 for neonatal chicks, 0.5ml for chicks up to 4 weeks of age, and proportionally up to 5ml for an adult bird administered intramuscularly every 4 weeks. A prophylactic injection of vitamin E/selenium before translocation / transport appears to minimize the incidence of sudden collapse and death.
Important B Vitamins Vitamin B_2 Biotin	Curled toe seen at hatching Weakness, paralysis, twisted legs and slipped tendon.	Water soluble vitamin supplement can be added to the drinking water until chicks are 4 weeks old and whenever deficiency is suspected. Vitamin B complex injection at 1 ml/10 kg body weight
Pantothenic acid	Inflammation of the skin around the beak, eyes and limbs	0.5ml for young chicks up to 4 weeks every 2 or 3 days
Niacin	Feather loss on the head and neck Poor hatchability of eggs Poor growth of chicks	A biotin supplement which contains biotin 0.3g/kg, pantothenic acid 30g/kg, and Vitamin C 200g/kg is available and can be added to the feed daily at 1g/kg of feed
Folic acid	Poor feather development late embryonic death. bending of the tibiotarsus, defects of the mandible	
Calcium, Phosphorus and Vitamin D	Limb deformities (rickets in young birds).	Correct calcium to phosphorus ratio in the diet Supplementation with limestone grit or crushed bones.
Manganese	Limb deformity especially slipped tendon	Addition of at least 120g/1000kg of manganese/feed Addition of manganous sulphate or manganous chloride to the drinking water at 2g/10 litres
Zinc	Limb deformity and enlarged joints Hyperkeratinization (thickening of the skin) of the feet and legs	Zinc should be present in formulated feed at 80g/100 kg Use of galvanized water troughs.
Essential fatty acids. Linolenic, Linoleic and arachidonic acids	Reduced hachability and chick survival	Supplementation with vegetable oils and fish oil

described in mammals and other avian species. Other possible causes of acute degenerative myopathy may include intoxication with furazolidone, ionophores and cassia. Overzealous supplementation can result in selenium toxicosis and this must be guarded against. Rae (1992) concluded that vitamin E supplementation is safer and appears to prevent mortality.

Paresis of the limbs of two 4 – month – old ostriches fed a diet predominantly of crushed maize was investigated by Van Heerden *et al.* (1983). Raised levels of serum aspartate transaminase and creatine kinase were demonstrated in both birds. The less severely affected ostrich recovered after a single intramuscular injection of vitamin E selenium preparation but the other died despite therapy. Their findings suggested a diagnosis of vitamin E-selenium deficiency which resulted in muscular degeneration and necrosis, fibrinoid degeneration and necrosis of some arterioles. Other workers also reported nutritional muscular dystrophy in a clutch of ostrich chicks, fed mainly on lucern which responded to treatment with vitamin E and selenium.

Porosis of the ankle or stifle may develop in fast growing chicks at the age of 4 to 8 weeks which is associated with a shortage of manganese in the diet. This may results in impairment of growth of the long bones and the Achilles tendon slipping. Manganese must be supplemented to a level of at least 200ppm, too much calcium and phosphorus should be avoided. Another nutritional disorder is starvation as a result of young ostrich chicks refusing to consume food. Food intake may be stimulated by inclusion of small pieces of lucern, egg or sea shells, or small stones on top of the balanced diet. Another method is the introduction of older chicks, which may stimulate the ostrich chicks to copy their actions when feeding. Anorexia occurs in other birds apart from chicks which lose their appetite from stress, diseases, trauma, exhaustion or other undetermined causes.

Symptom of anorexia include empty intestines on palpation of abdomen. Anorexia can be treated by one or more of the following procedures:- Addition of soluble vitamins to the birds drinking water. Injection of vitamin B complex as recommended by manufacturers or other appetite stimulants. In extreme cases of anorexia force feeding using semi-fluid meals. Molasses diluted 1:3 with water is also useful. A dosing gun can be used to push the food down the oesophagus. A clinical case of monensin poisoning in ostriches was reported by Gregory *et al.* (1992). Analytical results and histopathologic changes in intercostal muscles and liver supported the ionophore toxicity diagnosis. Cases of hydrocyanic acid (HCN) poisoning due to excessive intake of grass sprouts early in the wet season and the poor condition of birds at the end of the dry season resulted in high mortality in Namibia – Naukluft park (Kok, 1980). Ingestion of foreign materials such as wood shavings, sharp pointed sticks occurs when ostrich diet is not balanced. The foreign objects may penetrate the proventriculus and result in the death of the bird especially the young ones less than 6 months old.

Impactions: Impactions is one the most frequently observed problems in growing chicks to adult hood. Two types of impactions are recognized namely: acute or newly acquired impactions and chronic or long standing impactions.

Acute impactions usually result from a bird eating too much of unusable material very rapidly. This type of impactions can result from intake of sand, dirt, gravel, hard grasses and so on. Death in these cases is often quick due to the over-extended and non-functional condition of the proventriculus. Chronic impactions usually result from the bird having a partially impacted proventriculus which allows some material to pass through normally. These birds do not gain weight normally. They often appear malnourished and tend to eat excess non-food materials. Impaction in ostriches may result from many reasons such as nature of the feed, stress factors and the environmental factors. The feed factors that lead to impaction in the birds include:- Excessive fibre content:- for example in young chicks, intake of (alfalfa) Lucern stalks and leaves, stalks of grasses, especially in chicks kept on pastures in paddocks. Excessive ingestion of hard seeds, dry grasses and wild fruits may lead to impaction in older ostriches. Consumption of excessive quantity of high quality ration by young chicks, which they have not developed the capacity to digest. Rapid or sudden change in diet, from low to high-fibre rations. Poor quality fibre should not be offered to birds under the weight of about 35 kg. The animals factors that can result in impaction in the ostrich are:-

Inability of the young birds to digest fibre because of the lack of cellulose digesting bacteria in the caeca and colon. Chicks left hungry for long periods without feed hence eating a lot of foreign materials, such as sticks, strings, plastic tags, bones or wire. Other factors that lead to impaction on ostriches can be grouped under environmental/management such as: -Chicks raised on sandy floors may eat excess sand if the floor is soft or wet. Stress leading to displacement feeding. Also specific nutritional deficiencies leading to depraved appetite.

Lack of grift and small stones to assist in grinding ingesta in the gizzard may initiate impaction in the birds. Infection for example Candida and Megabacteria can lead to impaction. Nutritional deficiencies may lead to depraved appetite.

Prevention of Impaction: Impaction can be prevented by avoiding the causative factors on a farm. The management of the ostrich farm should train the bird handlers on how to prevent the problem. Impaction is not likely to be a major problem under intensive bird feedlots but it can be a significant cause of mortality in young chicks under semi-intensive systems where chicks have access to pastures freely or on restricted basis. Chicks previously confined to concrete and turned out to pastures for the first time usually get excited and tend to eat almost anything which may initiate impaction. Early treatment with some form of oral lubricant such as vegetable oil can help to breakdown some of this

material and get the bird back to a normal diet. When diagnosed early, surgical intervention can be very successful in removing the impacted material. Oral dosing of Epsom salt (magnesium sulphate) in water $^1/_4$ teaspoon for a small chicks to 2 tablespoons for an adult bird.

Coprophagy: Under natural conditions, newly hatched ostrich chicks consume their parents fresh faecal material which may be the source of micro-organisms that reside in their digestive tract.

Feather pecking: Feather pecking in birds can be corrected by feeding ostrich lick at 100-150 g/bird/day. Ostrich lick contains 25% protein, 0.3% Methionine, 1.36% Lysine, 1.67% Arginine, 0.25% Tryptophan, 7.0% Fibre, 6.97% ME, 3.9% Calcium, 2.1% Phosphorus and 5% Salt (Johnson, 1999).

Obesity: Excess energy above the birds requirements for maintenance, growth or reproduction leads to obesity. The thickness of fat in the ventral abdominal wall is a good indication and may vary from nil to 8 cm in thickness. Condition scoring of the birds can be carried out (scale 1 to 4). This is done on the curvature of the back viewed from the side, the amount of fat bulging around the tail and the shape of the abdomen viewed from behind. The spine over the thorax, can be palpated just anterior to the sacrum. Obesity may lead to decreased libido, low egg production and susceptibility to heat. Obesity can be controlled by monitoring feeding of the birds

Conclusion: Ostriches are monogastric herbivores which when managed intensively must be provided with adequate balanced ration containing optimal fibre levels. Nutritional disorders in ostriches can be prevented which result in expensive losses to the farmers when it occurs. This review covers all aspects of ostrich feeding and nutrition which will enhance successful ostrich farming.

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