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Studies on Ostrich (*Struthio Camelus*) – Review

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SUMMARY

Ostrich has been reared in Hungary for decades, but we have limited information on this species. The aim of this review was to provide a concise description of the ostrich (Struthio camelus) based on international studies. We were to investigate some of the most relevant parameters, such as egg, meat and skin production. In this critical review we managed to sum up the most significant features and productivity parameters of ostrich and effecting factors. So as to make an accurate description of the species we have to know its morphological, behavioural and physiological characteristics. Ostrich is a very special bird with special nutritional and environmental requirements. Ostrich products, regarding egg, meat and skin are considered luxury products not only in Hungary but also abroad. Though egg has a significant nutritional value, it is mainly used for hatching chicks. In Europe we can expect roughly 40–50 eggs from a hen yearly. Ostrich has a lean meat with high protein and low fat and sodium content, moreover it is rich in minerals and polyunsaturated fatty acids. Having these advantageous qualities, ostrich meat should be part of our healthy diet. Skin production is not important in our country, but there is a special demand for high quality ostrich leather globally. In the future our aim is to conduct a research on some of the parameters. As low production rate and embryo mortality is a great deal of problem in ostrich industry, we need to investigate the incubation environment. There is an apparent disagreement among researchers on optimal slaughter age. This is also an area for further investigation. The value of skin and effecting factors on our climate as well as adaptability of the species are also worth for further investigation together with the nutrition what differs from other ostrich breeding countries. Nowadays, there is a great emphasis placed on animal welfare too.

Keywords: *ostrich (Struthio camelus), behaviour, ethology, adaptability, egg production, meat production, red meat, skin production*

INTRODUCTION

The ostrich was domesticated in South Africa in the 19th century in order to use its feather to make fashionable women clothes. From 1980 intensive ostrich industry was initiated on the basis of feather, meat and leather production. The *Struthio Camelus* species has different subspecies as Red Necks (*Struthio camelus massaicus, Struthio camelus camelus*) Blue Necks (*Struthio camelus molybdophanes Struthio camelus australis*) and the South African Black Neck (*Struthio camelus domesticus*), on which the ostrich industry is built and was created by the synthetic cross of the *Struthio camelus camelus* and the *Struthio camelus australis* (Engelbrecht, 2013). There have been many studies conducted on production and genetic evaluation of ostrich. In this study our aim was to compare these results and draw the conclusions. Three main economic values of the ostrich are egg, meat and skin. Human consumption of ostrich egg is not significant, as it is concerned as a luxury. Even though it is known for its high nutritional value, is rather used for hatching chicks (Kokoszynski, 2017). Meat production means mainly raw meat, steak, dry goods and hamburger meat (Al-Nasser et al., 2003). The significance of ostrich was that it could replace beef as an alternative red meat source in the case of BSE (Poławska et al., 2011). Additionally, ostrich meat is ideal as a healthy diet due to its low fat and cholesterol content (Poławska et al., 2011) and high amount of polyunsaturated fatty acid content (Paleari et al., 1998). Skin is particularly used for making items, accessories and jeweleries from it. In the current review we are to present this species regarding these qualities and attempt to focus on those parameters which have been investigated so far and we plan to research them.

MORPHOLOGY AND MORPHOLOGICAL ABNORMALITIES

Ostriches are the largest flightless birds in the world, having a maximum 150 kg weight and 1.8–2 m height (Hallam, 1992). Adult males have black body feather and white primaries and tail feather, females and young males are brown or similar to ash (Davies and Bertrem, 2003). Living in the African Savannah, ostriches have to rely on their locomotor abilities to make long distances seeking for nutrition or to survive from predators or the aggressive ones (Williams et al., 1993). Ostrich can run at a pace of 60 km/hour, so that a really special leg anatomy and locomotor system is expected to achieve it (Deeming, 1999).

There are several morphological abnormalities observed in ostrich and many of them are related to the limbs. Pelvic limb deformities are frequent among captive-reared ostriches, especially tibiotarsal rotation which results in a decreased meat production. The rotation occours as a consequence of rapid growth between the 2nd the 10th week of age. The condition of chicks steadily worsens until chicks are unable to walk. It can be caused by various environmental factors, as well as insufficient nutrition or exercise (Hahulski et al., 1999). Spread bow leg is also a common disease among ostrich, which the result of the improper vitamin supplementation or rapid growth (Cooper et al., 2010a).

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ETHOLOGY AND ADATABILITY

Daily routine and sexual behaviour

Daily routine

The six most common behaviour patterns are standing, walking, trotting, sitting, foraging and pecking (Mbaya, 2015). The observations of Mc-Keegan and Deeming (1997) are in agreement with Faki (2001), that ostriches spend most of their time standing, except for bathing, resting and nest-making (Degen et al., 1989). During the summer, trios and pairs show the greatest difference in their behaviour (Mc-Keegan and Deeming, 1997). Layers spend twice more time with foraging and pecking, than males, but males pace two times more than females. When ostriches peck they do not sort out things (Ross and Deeming, 1998; Degen et al., 1989). As breeding season is coming, hens and males display a kind of aggression, which becomes stronger while going into summer. They are violent toward juveniles, other species and even each other (Bolwig, 1973). According to Deeming (1997) ostriches sit more in rainy weather, than in dry periods. As for the time of the day, they stand more in the morning, than in noon, and spend more time with drinking and foraging in the afternoon (Ahmed and Salih, 2012). Also Mbaya et al. (2015) demonstrate, that ostriches are more active in the morning and rest more in the afternoon due to the hot temperature. Most hours spent with walking in this study agrees with the observations of Cooper et al. (2010b). We should mention yawning and stretching as the most important maintenance activities. Yawning occurs right after hatching as the consequence of tiredness. Chicks get tired after moving some meters in the nest, then they gather, yawn deeply and stretch. Yawning is generally displayed before sleeping, stretching is showed after waking up. These activities are endogenous and are to regulate the work of the breathing and circulatory system. These activities can be triggered by the lack of oxygen (Dumpert, 1929), or a homeostatic connection between the central breathing system and the extrapyramidal path (Selbach and Selbach, 1953). Running and dancing can mean a game, but it can be the sign of threat, when they hear unknown noises. One-week old chicks run and dance the most compared to the elder ones. They also like bathing in the sand, mainly in the afternoon (Amado et al., 2011; Alvarenga, 2006; Csermely et al., 2007). As for their thermoregulatory activity, they open their beaks and pant, and open their wings. They use their wings against hot climate to regulate temperature, as well as to protect their chicks and eggs, and to show courtship. To heat themselves, they lay down and cover their thighs with their wings. They are able to freeze instead of going into the pen, that is why we have to close them in winter (Samson, 1996). Since ostriches do not have uropygial gland, grooming is not a dominant behaviour. Instead of grooming they have a bath in the sand or dust (Samson, 1996). We can also find ostriches trembling with threats, which is caused by the stress due to being cornered or transported. This is the sign of concern, rather than being cold. When they are afraid of something, they raise their tail feathers up, hiss, open their wings and ruffle their feathers, especially on their neck. It can be seen mainly on males. Forward kicking is mostly performed by juveniles and adults in the breeding season. When an individual meets an aggressive one, it runs away or submits itself without defend. Such animals can even die from stress, injuries or exhaustion (Samson, 1996).

Sexual behaviour

According to observations 80 % of females make relationship with one male, 20 % of them mate with several males during the breeding season (Blach et al., 2000). It is typical of their courtship behaviour, that females initiate relationship. If a potential male appears, they pose in front of him and send other females and juveniles aggressively away. The female expresses her physiological readiness to mate by a clucking sound made by rapidly opening and closing her beak (Samson, 1996). The redness of the beak and the skin of neck, thigh and foot can be seen in males, when they accept the female closing to them. If the males want to mate, they display courtship to the female (Sauer and Sauer, 1966). The female lifts its wings up and down, put down its head and lifts up its neck and tail and urinate on the ground. Before mating the male stamps several times, puts one of its legs on the back of the female and attempt to find cloaca contact. During mating the male displays the movements of courtship and groans at the end of the mating (Sauer, 1972). These patterns were observed by Bolwig (1973) as well. The mating lasts for about 1 minute, while the female does not show any special signs except for opening beaks and stretching its neck ahead. The female which mates with the male first becomes the major female. It lays eggs first in the middle of the nest, then the consecutive females become minor females and start to lay eggs two or three days after the major one. Females lay eggs every second day, but major females can visit the nest every day. In this case, when a minor female comes sometimes it has to wait for the major one to allow her lay egg. This waiting time can last for 20 minutes. The major female waits for her laying eggs then sits back. Laying takes only a minute, but minor females attempt to appear to lay eggs when the major hen is not present. The major hen lays about 9–14 eggs in a nest, altogether 26 during the breeding season, the minor ones (generally 3) lay 3–20 eggs, with an average 11 (Bertram, 1992; Muhsi et al., 2008; Patodkar et al., 2009). They lay them in the late afternoon or in the early evening and to fill a nest they need 30 days. Males also can display courtship against each other, but this is the sign of aggression, when they appear on each other's territory. Guarding and hatching is the duty of the major hen and the male, respectively. The male spend 71 % of his time hatching eggs one day. They switch in the morning and in the afternoon as well (Sauer, 1972).

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Abnormal behaviours

Feather pecking

They pick each other's back and tail feathers. It can be triggered by stress, overcrowding, boredom and occurs more frequently in winter due to the long closed period (Stewart, 1994). Toe and face picking can be a serious problem, when the ostriches peck even each other's eye lids. Causes are the same as in feather pecking (Samson, 1996).

Stargazing

Individuals showing this abnormal behaviour permanently raise their head, and put it on their back. After a while it is difficult for them to walk, eat and drink. It can appear as the consequence of confinement or the lack of thiamine (Samson, 1996).

Anorexia

It occurs when in a pan animals displeased by using feed and water containers and avoid them. It can happen if they are fed with mouldy feed or water with high chloride content. If they are not supplied with other feed they can starve to death and dehydrate themselves (Samson, 1996).

Dietary indiscretion

Ostriches do not only consume what is good for them. There are many cases not depending on age, that they pick up metal pieces and sharp items due to stress or curiosity. It is very serious, since it causes perforation or gastric stasis in the gastrointestinal tract (Honnas et al., 1991; Gamble and Honnas, 1993).

Pica

Eating feces in chicks is a completely right activity, because they can get microflora which is necessary for digestion. In captive ones this behaviour can occur excessively, which can lead to illnesses (Samson, 1996).

Antagonistic behaviour

Ostriches can express aggression against their mates and also humans. They attempt to chase and kick the ones who are not favorable for them. It occurs especially at the onset of puberty. Mainly males show aggression against people, which fluff their feather, lift up their wings and tail feathers and attempt to kick the men.

Among these abnormal behaviours the most common and dangerous is the dietary indiscretion especially in chicks during winter (Samson, 1992). If housing facilities and management techniques are appropriate these abnormalities can be prevented.

Interspecific contacts

Curiosity and playing among ostriches and other species are very rare patterns. Meeting other birds or mammals they are sorely sensible, cautious and shy. They strictly stick to others in their group regardless of the sex and age. Ostriches attempt to avoid interaction with other species. They are usually not concerned about ¾ of individuals when encountering, ostriches tolerate and avoid them. Against ¼ of other animals they show aggression or threat and send them away from water or nutrition resources (Sauer, 1969).

EGG PRODUCTION, EGG QUALITY AND HATCHABILITY

Egg production

Ostrich has a longer productive life-period compared to all poultry species (Ipek and Sahan, 2003). In the wilderness they mature at the age of 4–5 years the male and the female, respectively (Reiner, 1995), while among domesticated circumstances at the age of 3, the females mature earlier, than the males (Smith et al., 1995). Female lay 12–18 eggs in one breeding season in wild. Conversely, in farms they produce 40–60 eggs (Ipek and Sahan, 2006). Layers are able to lay eggs even until at the age of 40 and reach the peak at the age of 7–11. In Africa ostriches produce 30–35 % more eggs than in Europe due to the more ideal climate conditions (Reiner, 1995). There are many factors influencing egg production. Some of them are related to the environment (temperature, feed, health condition). According to Bowsher (1992) they lay the most eggs in June and July and the hatchability rate is the best in August. As we are closer to the end of the year, the number of eggs decreases. The years spent with laying eggs is also a significant factor in egg production. The results of Ipek and Şahan (2003) show that the more years a layer produces eggs, the more eggs she lays and also the longer the length of the breeding season is. The month also has a significant effect on the quantity of eggs produced. In May they produce the most eggs and egg production decreases drastically by February (Wőhr and Erhard, 2005). The ostrich is a seasonal species, the egg production period lasts for around 6–8 month. This trait is in relation with the length of the day-period and it is the most intensive when the day-period is long (Mellett, 1993). Lambrechts et al. (2004) examined the effect of sex ratio on egg production and they found, that comparing trios with harems, in trios the quantity of eggs produced can be raised to some extents in contrast to the harem, but in large populations (harems with 120, 130 individuals) the fertility and hatchability of eggs decrease. Shanawany (1999) also investigated sex ratio and found that with 1:1 incompatibility between hen and male can cause a problem. Natural selection is better in this case. 1:2 ratio showed to be the best, because with 1:4 fertility is not that high. Deeming (1996b) confirms the latter statement, that 1:2 sex ratio is better than a larger resulting in lower fertility.

Egg quality

Ostrich lay the largest egg among poultry species, which has a stiff and firm shell. The 1.1–1.5 kg weight of the egg is affected by subspecies, the weight and age of hen, and the feeding technology (Deeming, 1996a). Regarding egg weight, Deeming's (1996a) statements are in agreement with Mushi et al. (2007) and Brand et al. (2003), who found it 1321 grams and 1347–1446 grams, respectively. According to Koutinhouin et al. (2014) the average length of egg is 15 cm and the width is 12 cm, found the same by Mushi et al. (2007). Using these parameters by dividing by each other we can calculate one of the most important parameter of egg, which is egg shape index (SI). This parameter is

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calculated by the following formula: (W/L) x100; W=width of the egg, L=length of the egg (Anderson et al., 2004). The average shape index in the investigation of Moreki et al. (2016) is 82.65 %, which is in agreement with Horbańczuk et al. (2003), Nedomová and Buchar (2013), Benoît et al. (2014) and Selvan et al. (2014), who received 83 %, 82.49 %, 83.5–83.86 % and 82.86 %. In their study Nedomová and Buchar (2013) found that the minimum of SI was 74.48 %, the maximum of SI was 89.72 % and the average showed 82.49 %. The egg weight changes during the breeding season. From the first day to the 40th increases exponentially, then starts to decrease from the 60th day (Superchi et al., 2002). The authors suggested also that the larger is an egg, the larger is the weight/surface index is. In those eggs, of which the weight/surface index differs the most from the average (W/S=2.65), embryo mortality is more likely to happen due to the abnormal development, suffocation and the bad air conductance of eggshell. The average thickness of eggshell is 2.6 mm, which makes up 15–20 % of the egg size. Eggshell is a curiosity in arts and crafts, which serves as the base of different jeweleries and furnitures (Di Meo et al., 2003). As for egg shell thickness, Mushi et al. (2007), Selvan et al. (2014) and Cooper et al. (2009) measured much lower values, such as 1.65 mm, 2.4 mm and 2.24 mm, respectively. The porosity of ostrich egg is an important factor, because the quantity and size of pores, as well as the thickness of eggshell have a great impact on the water loss of eggs. If water loss is inappropriate, embryo mortality increases (Deeming and Ar, 1999; Brake et al., 1993). According to Moreki et al. (2016) ostrich egg consists of 60.5 % of albumin, 26.04 % of egg yolk and 13.36 % of egg shell. These parameters were also investigated by Koutinhouin et al. (2014) who found them 57.1–59.4 %, 21–23.3 % and 19.6 % and Selvan et al. (2014) who observed 57.51 %, 27.64 % and 14.83 %, respectively. The composition of egg also changes during the breeding season. In the onset of the breeding season the quantity of egg yolk is larger, than of the albumin and the mass and mineral content also increases exponentially from winter to spring, respectively. The raw protein content of albumin reaches the maximum on the 60th day. Albumin poses a bacterial defense, since if its viscosity increases, it blocks the movement of bacteria. 30 % of egg yolk is lipid**,** which component is essential for the embryos' nourishment, because it covers 90 % of their energy intake (Speake et al. 1998; Noble et al., 1996).

Hatchability

Ostriches lay 60 eggs in a nest per year. The hen and the rooster hatch them respectively, which lasts 42–44 days. In artificial incubation it is 39–42 days (Accomando, 2007). Today in farms generally artificial incubation is applied. Artificial incubation is an essential part of ostrich breeding, but we still do not possess sufficient knowledge regarding it. Ostrich industry is facing a remarkable problem in reproduction, which means that the mortality among chicks and embryos extremely high due to incubation failures. Deeming (1995) mentions bacterial infection as being one of the most determining causes. Secondly malpositioning is also a significant effect mentioned by Ley et al. (1986) causing 55 % mortality in combination with oedema. Krawinkel (1994) observed 81.8 % fertility and 16.6 % and 48.2 % hatchability for naturally and artificially incubated eggs due to these problems. In their study Rizzi et al. (2002) found hatchability of set eggs being 51.5 % and of fertile eggs being 73.9 %. The result of set eggs was lower than the 70 % reported by Dzoma and Dorrenstein (1998). In order to avoid this situation and to improve in rearing ostriches we have to take factors affecting hatchability into consideration and initiate investigations on the egg production abilities of this species. Hatchability is also determined by the fertility of female and male. The quantity of sperm is between 1 and 2 ml. The quantity and quality of sperm and male libido were the highest in spring-early summer (Bonato et al., 2014). The length of incubation depends on many factors. Older females lay larger eggs, which need more time to hatch and the size of egg increases by time as well (Laing, 1992). Restoration period and the effect of month are also crucial aspects. Hatching is shorter in May and longer in September in its natural environment, but can be different in other countries depending on the climate and weather factors. Warm climate and weather facilitate hatchability. Hatchability is influenced by the subspecies, the egg size, the egg weight, the quality parameters of the egg, the length of the restoration period and the method of restoration (Laing, 1992). King'ori (2011) observed the average incubation temperature to be 37.8 °C, though in their study Hassan et al. (2004) found that the ideal incubation temperature is below 37 °C, which has a positive impact on hatchability. It has a close resonance with the claim of Foggin and Honywill (1992) that optimal incubation temperature should be between 36 °C and 36.5 °C and the relative humidity of between 20 and 30 %. Eggs should be placed with the sharp side down, leaned in 45 degrees and be turned until the day 39 and we should candle them on the 2nd week (King'ori, 2011). Conversely, according to Van Schalkwyk et al. (2000) improved hatchability can be reached of fertile eggs turned 60 degrees hourly in eggs set horizontally for 2 or 3 weeks, then vertically for the remaining period. While the optimal relative humidity demonstrated by King'ori, (2011) is between 25–50 %, Stewart (1995) suggests 15–20 %. Relative humidity besides influencing water conductivity of the eggshell, effects the available quantity of minerals for the chick and also for gas exchange (Wilson, 1996). El-Safty (2012) suggests, that hatchability is influenced by egg weight. Those eggs hatch easier, with a better percentage, which are lighter, under 1350 grams, but over 1451 grams hatch the least. The inappropriate water conductivity of egg leads to large, oedemic, non-viable chicks. If too much water releases from the egg it causes that small, weak and dehydrated chicks hatch. It shows that we should select and breed those animals which lay good quality eggs with uniform porosity (Wilson, 1996).

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MEAT PRODUCTION

Ostrich meat is regarded as a healthy red meat with low content of intramuscular fat content. Most valuable meat parts found on the thigh, least on the back (Sales, 1999). At the age of 10 month ostriches produce an adequate quantity of raw meat, with a cut rate of about 57–58 % and the percentage of lean meat is 62.5 % (Sales, 1999). As for meat composition, it is typical of the flavour of beef and the low fat and cholesterol content which is the characteristic of poultry meat (Poławska, 2011). This statement is supported by Hoffman et al (2008). Comparing with beef and poultry, ostrich meat has the same quantity of total fatty acids, but is richer in polyunsaturated fatty acids, but has a lower percentage of monounsaturated fatty acids. Regarding fatty acid content of the different muscles, neither Sabbioni et al. (2003) nor Horbañczuk et al. (1998) found a difference between them. Ostrich meat also contains more minerals, phosphorus, manganese and iron and less sodium than the mentioned ones (Paleari et al., 1998). Their study has a close resonance with Balog et al. (2006) that the iron content of ostrich meat is higher than of other poultry meat. Less sodium content is also mentioned by Cooper (1999), adding that because of this feature, this meat is suggested for people suffering from hypertension. Comparing the different muscle types on the subject of these parameters, Mejewska et al. (2009) stated that all of them have similar dry matter, protein and ash content. Regarding the content of vitamins, especially B-group and vitamin E were found as high as in beef or higher than that (Lombardi-Boccia et al., 2005; Karklina and Kivite, 2007). As for slaughtering age, Sales (2002) found dry matter and fat content of muscle deriving from older chicks (10–12 month) higher, than of younger ones (8 month). Juiciness and tenderness of ostrich meat is similar to beef (Taylor, 1998). The age of slaughter is also an economically relevant factor, but is still not obvious at which age should be accomplished. The results of Jordaan et al. (2008) show that comparing animals of 8.5, 10.5, 12.5, 14.5 and 16.5 month of age in cold carcass and skin size, the income was the highest when slaughtering in 14.5 months, but the gross margin of the 10.5 system was the highest. The authors suggest that the older the individual is, the greater the cold carcass yield and skin surface are, but not only these qualities increase with time, but also the feed intake and feed conversion rate of animals. So, we should take into consideration which age we choose for slaughtering. Deeming (1999) claims that a younger slaughter age is favourable at the age of 8–10 month, but conversely according to him the subjective of the South African market is to slaughter them at the age of 14 month, because optimal leather quality can be attained at this age, though acceptable meat yield is already achieved at the age of 10 month. Pollok et al. (1997) make a difference between subspecies and say that the optimal slaughtering age for African Black is 12 to 14 month and that for Red and Blue Necks is 10 to 12 month, respectively. According to them these ostriches reach the best meat, feather and leather quality in that age.

SKIN PRODUCTION

Even though skin is also a luxury product in the exotic market (Adams and Revell, 2003), we have a little knowledge of its features and it's influencing factors. In order to have further information on this parameter, it would be suggested to investigate in Hungary. The quality of skin depends on the existence of damages on it and also the market is interested in tenderness as well to decide whether that piece of skin is useful or not (Sales, 1999). So called nodules can be found on the skin, which size, shape and dispersion have a great significance in terms of market ability of the product (Holtzhausen and Kotzé, 1990). Cloete et al. (2004) submit, that it is widely accepted to slaughter the animals at the age of 14 month, otherwise the shape of the nodules and the size of skin are unfavourable. The main measurement points on the skin are the neck, the middle crown area, upper thigh, flank and the back.

ANIMAL WELFARE

According to OIE (2018) the definition of animal welfare is the following. An animal is meant to be in a good condition, if it is healthy, well-nourished, feels good and safety, has the opportunity to show natural behaviour, and does not suffer from any displeasing feelings, such as ache, fear and stress. Ostriches are large animals, which can pose danger for each other and also for humans. Knowing their response can help quiet a lot in how to approach them. Ostriches are usually transported as day old chicks, 3 month old chicks or 3–6 month old chicks (Wotton and Hewitt, 2011). Bejaei and Cheng (2014) examined the response of ostriches against handlers. Before being hooded, the birds tried to escape by kicking and jumping inside the holding paddock. After that they calmed down in less than a minute and were able to walk into the sampling fold. During transport those ostriches which were heavier lost more weight. This defending behaviour regarding forward kick was also recorded by Wotton and Hewitt (2011). Mills and Nicol (2000) also underlines that handling always walks with stress and humans hardly pay attention not to hurt and cause damages to ostriches, whereas it would need attention. Other authors mention the significance of gentle, but relatively close relationship between human and ostrich chicks. Reiner et al. (1996) suggest that an everyday connection between handlers and young ostriches can help reducing stress during treatments. According to Muvhali et al. (2018) extensive human presence including gentle voice and physical connection, can stimulate the immune system of chicks resulting the survival rate being higher. Non-living environmental factors also have influence on ostrich welfare. Horbanczuk (2002) highlighted, that the photoperiod should be 24 hours during the first two days with 90–100 Lux intensity, then it is decreased to 16–18 hours with 20–40 Lux. As for stocking density, Kreibich and Sommer (1995) claim that the minimum floor space per one chick until the age of 8 month is between 0.25 m^2 and 5 m^2. Shanawany (1999) describes 0.5 m^2 floor space per chicks for the first week. Stunning, mentioned by Mitchell (1999) applied before

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slaughtering also makes part of animal welfare. The objective is to cause immediate unconsciousness to make the bird insensible to pain and stress.

CONCLUSIONS

Having data on the productive and reproductive parameters mentioned in the article, it can be revealed, that we have a sound knowledge regarding ostrich breeding. However, to make a comprehensive study, more parameters and aspects should be examined besides the mentioned ones, such as adaptability, embryo mortality, skin production and other traits, all of them in local conditions. As for reproduction, it should be useful to know the exact method of artificial incubation, especially the required egg weight, which is optimal to reach the best hatchability and humidity, which is one of the greatest risk factors in incubation. Since embryo mortality is usually extremely high in ostrich, we need to examine it in the early, middle and last part of incubation and attempt to find the correlation between hatching conditions and the extent of it in order to provide a better practice for incubation. It can be interesting measuring the thickness of eggshell deriving from dead-in-shell embryos so as to find a relationship between these two factors. We are to follow the growth performance of chicks and survey the connection between this trait and of egg quality. In this case we should know some of the external and internal features of the egg. We would measure the chick weight and the size of its body parts at hatching, at the age of 21 days, then monthly and we would make a growth curve regarding the whole body and the different body parts, respectively. It would help us determine the right age of slaughtering, though we should confirm our results by conducting an economic analysis, too. We should have more information on skin performance, so we would use growth curve to follow the skin production abilities of ostrich. In addition, we should get more information on the ethology and adaptability of ostrich and understand the principals of animal welfare to do our best in practice.

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