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Original Article

Comparative Study of Egg and Meat Quality of Guinea Fowl under Different tropical regions: A Review

■Author(s)

Rayan GN[I] https://orcid.org/0000-0001-7677-123X
Mansour A[I] https://orcid.org/0000-0002-5963-5276
Fathi MM[II] https://orcid.org/0000-0001-9207-3861

[I] Department of Animal and Fish Production, College of Agricultural and Food Sciences, King Faisal University, Al-Ahsa, 31982, Saudi Arabia.
[II] Department of Poultry Production, Faculty of Agriculture, Ain Shams University, Hadayek Shoubra, Cairo 11241, Egypt.

■Mail Address

Corresponding author e-mail address
Gamal Nasser Rayan
King Faisal University - Animal and Fish Production - Al-Ahsa, 31982, Saudi Arabia
Al-Ahsa 31982 - Saudi Arabia.
Phone: +00966 546975218
Email: gahmed@kfu.edu.sa

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ABSTRACT

Guinea fowl have several advantages over chickens. These birds are highly valued for their meat and eggs, particularly in tropical regions. They are currently in many parts of the world. Recently, the demand for guinea fowl meat has increased because it is considered a high-quality protein source. In addition, their eggs are delicious and considerably better than those of chickens. Guinea fowl eggs are valued for their thick shells, and longer shelf life, and it has premium prices compared with commercial and indigenous chickens. Chicken eggs have been well studied for egg and meat quality. However, such information isn't so sufficiently documented in other poultry species. Despite the interest in guinea fowl production, it is vital to take cognizance of the fact that there is a lack of information on the production and quality of guinea fowl products, in contrast to commercial chickens. Therefore, the present review aims to assess the egg and meat quality of Guinea fowl in different tropical regions. The main results of the current study showed that the external egg quality characteristics, mainly (egg weight, shell percentage, and shell thickness), and internal egg quality traits, mainly (albumen weight, haugh unit, yolk height, and yolk color) of Guinea fowl differed under different tropical regions. Concerning carcass characteristics, a clear difference was observed in dressing percentage and breast percentage of Guinea fowl in various tropical areas. A similar trend was observed for the meat color.

INTRODUCTION

Poultry meat and eggs play a significant role in overcoming protein malnutrition, which is considered a common problem in many African countries (Ahaotu *et al.*, 2017). Guinea fowls (Numida meleagris) are highly valued for their meat and eggs. They are initially from Africa, where they retain their original traits, and their rearing is being popularized due to the ease of keeping them. Guinea fowl are exciting birds that have been bred for centuries. They are very resistant to most diseases that affect chickens and have low production costs (Vineetha *et al.*, 2017; Ebegbulem, 2018). Literature shows that guinea fowl products are accepted worldwide and produced commercially on a large scale in some countries such as Australia, Belgium, Canada, and France (Robinson, 2000; Embury, 2001), while in most African countries, guinea fowl production is in its early stages (Saina, 2001). Recently, the demand for guinea fowl meat has increased (Sarica *et al.*, 2019). Guinea fowl meat is white like chicken meat, drier, and regarded as very lean. It may be considered a high-quality protein source due to being rich in vitamins and containing fewer cholesterol and fats (ICAR, 2021). Demand for guinea fowl meat is increasing throughout the world, and a healthier choice when compared with broilers, Guinea fowl meat has low cholesterol, low-fat content, and higher protein content (CAB,

1987). Guinea fowl meat has higher protein content (about 28%), an eviscerated yield of over 80%, and an outcome of the edible carcass between 50% and 80% (Ayorinde, 1990). Guinea fowl meat is regarded as tasty, gamey, and flavorful, renders high prices in restaurants compared with chickens, and is popular with health-conscious consumers (Bokkers & Koene, 2003). Guinea fowl reach 1.4: 2.1 kg of body weight in 65-91 days because of their higher adaptability, which means muscles and organs grow in harmony, and they have excellent meat quality regardless of various environmental conditions.

Guinea fowls could lay more eggs annually, and their keets grow faster than indigenous chickens (Chivandi *et al.*, 2002; Saina *et al.*, 2003). They have marginally more protein than chicken or turkey. Their eggs are delicious and considerably better than those of chickens. Guinea fowl eggs are noteworthy for their thick shell, a high proportion of yolk (Alkan *et al.*, 2013), high content of vitamins and trace elements (Bashir *et al.*, 2015), and longer shelf life, in comparison to chicken eggs, and it has premium prices compared with commercial chickens and indigenous chickens (Ayorinde, 1991; Guèye, 1998; Ikani & Dafwang, 2004). Chicken eggs have been exceptionally well studied for egg quality and composition, as well as meat quality. However, such information isn't sufficiently documented in other poultry species. Despite interest in guinea fowl production, it is vital to take cognizance of the fact that there is a shortage of information on the production and quality of guinea fowl products in contrast to commercial chickens. Therefore, the objective of the present study is to evaluate the egg, carcass, and meat quality of Guinea fowl in different tropical regions (Photo 1).

Photo 1 – Guinea Fowl layers.

Egg Productivity and Quality

In general, guinea fowls are used for laying purposes. During the season, the bird lays up to 190 eggs, relatively a higher production that may last for even 2 to 3 years (Gwaza & Elkanah, 2017). There is some diversification in laying characteristics between the bird's varieties (Onunkwo & Okoro, 2015b). Egg production of guinea fowl in captivity or the intensive system starts at 28-32 weeks, with 50-100 eggs being produced in the first year and more than 180 eggs being laid in the second year of production (Ayorinde, 1990). Layers may continue to lay eggs for seven years or more. External and internal egg quality traits are significant in poultry breeding, especially for the reproduction of future generations, breeding performance, quality, and growth traits of chicks (Islam & Nishibori, 2009). Kgwatalala *et al.* (2013) reported that all four varieties of helmeted guinea fowl studied (pearl, lavender, royal purple, and white) produced eggs of acceptable external and internal quality. Egg weight, shell thickness, the weight of yolk, and albumen are important egg traits influencing egg quality when other management conditions and fertility are not limiting factors (Farooq *et al.*, 2003). Egg quality is composed of those characteristics of an egg that affect its acceptability to consumers, such as freshness, cleanliness, shell quality, egg weight, yolk index, albumen index, Haugh unit, and chemical composition (Song *et al.*, 2000). On the other hand, the price is more important in some countries like India (Parmar *et al.*, 2006).

Egg weight

The weight of guinea fowl eggs ranges from 32 g to 42 g per egg, while the average egg weight is 38 g/egg (Khairunnesa *et al.*, 2016; Shaker *et al.*, 2019). Published reports also suggest that the egg weight of guinea fowl ranges between 38 to 45 g/egg (Fani *et al.*, 2004). The study by (Kgwatalala *et al.*, 2013) found that the royal purple variety had the highest egg weight (44.78 g) compared to other types of helmeted guinea fowl studied (pearl, lavender, and white), which recorded (41.42, 41.60, and 36.03), respectively.

On Table 1, we can observe that the egg weight of guinea fowl in recent studies and different countries ranges between 35.9 to 48.2 g per egg.

Egg shape and color

There are two types of shell colors for guinea fowl eggs, such as spotted cream and white (Khairunnesa *et al.*, 2016). Shell color of the eggs collected from

different areas observed, followed by the collection. However, both the shell colors were found. However, spotted cream colors were abundant compared to white color.

The shape of a bird's eggs is a matter of natural convenience rather than aesthetic consideration, and the overall form of an egg should be smooth to assist in laying. The egg shape index is defined as the ratio of the short border relative to the long edge (egg width ÷ egg length) x100.

Khairunnesa *et al.* (2016) reported that the egg shape of guinea fowl is unique and differs from the eggs of any other poultry species. (Onunkwo & Okoro, 2015b; Gwaza & Elkanah, 2017) reported that for guinea fowl, egg lengths ranged from 42 - 52 mm, and egg width went 35 - 38 mm. Mean egg length and width found by (Wilkanowska & Kokoszyński, 2010) were 49.4 and 37.47 mm, and by (Alkan *et al.*, 2013) were 49.47 and 37.89 mm.

Kgwatalala *et al.* (2013) found eggs of the pearl variety had a significantly higher egg shape index (76.29) than those of the other three varieties of domesticated helmeted guinea fowl (lavender, royal purple, and white), with values ranging between (73.97, 74.77 and 73.62), respectively. Egg shape index values which have an average of 76.60%,as reported by (Alkan *et al.*, 2013). Lower findings are 73.7% in meat or 74.7% in the domestic type of Guinea fowl, as written by (Nowaczewski *et al.*, 2008). Still, there are also higher values in the literature, such as 77.8% found by (Kuzniacka *et al.*, 2004). In recent studies and different countries, egg length of guinea fowl ranges 47 – 50.3 mm, egg width ranges 36.1 - 40 mm, and shape index ranges76-76.8,which means that the egg shape index indicates the standard shape of eggs, and higher value (78.8) reported by (Mohsenpour *et al.*, 2020), see (Table 1).

Eggshell quality

Zelleke *et al.* (2020) found that the weight, thickness, and percentage of eggshells were higher (p<0.05) for guinea fowl as compared to other studied chicken genotypes. (Ahaotu *et al.* (2019); Mohsenpour *et al.*, 2020; Zelleke *et al.*, 2020) reported that the shell weight of guinea fowl eggs was (6.17, 6.36, and 6.57), respectively, and lower values (5.83) were found by (Vekić *et al.*, 2018). The shell percentage of guinea fowl eggs was 15.23, and 15.60 % was found by (Vekić *et al.*, 2018; Mohsenpour *et al.*, 2020). Lower findings are 12.84 % reported by (Ahaotu *et al.*, 2019), but there are also higher values, such as 18.3% (Zelleke *et al.*, 2020).

Eggshell is a vital egg quality parameter considered in a breeding program to reduce eggshell breakage. Eggs with low-quality shells contribute to economic losses in producing eggs for consumption (Sinha *et al.*, 2018). A study by Zelleke *et al.* (2020), reported that eggshell parameters were higher for guinea fowl eggs versus all chicken genotypes studied. Previous results on eggshell parameters vary widely. A range of values for eggshell weight of 5.8 - 6.5 g (Alkan *et al.*, 2013; Onunkwo & Okoro, 2015b; Marinko *et al.*, 2018), and eggshell thickness of 0.30-0.79 mm (Bernacki *et al.*, 2013b; Onunkwo & Okoro, 2015a) are found for guinea fowl eggs, and Zelleke *et al.* (2020) results are within the range of reported values. Guinea fowl eggshells are more potent and thicker than the eggshell of chicken and duck. Khairunnesa *et al.* (2016) found that the average eggshell thickness of the guinea fowl eggs was 0.52 mm. Obike *et al.* (2011) found an average thickness of 0.48 mm in Pearl-type guinea eggs. Kgwatalala *et al.* (2013) reported that the eggshell thickness for the different varieties of the helmeted guinea fowl ranged from 0.42 to 0.56 mm, which were all above the critical eggshell thickness of 0.33mm, below which the risks of egg breakage and entry by micro-organisms is increased (Chineke, 2001). Vekić *et al.* (2018) found an average shell thickness (0.49 mm); similar values for thickness (0.48 mm) are reported by (Kuzniacka *et al.*, 2004). A lower value of eggshell thickness (0.41 and 0.44 mm) was found by (Bernacki *et al.*,

Table 1 – External egg quality characteristics of Guinea fowl under different tropical regions.

Trait	Bosnia and Herzegovina Vekić *et al.* (2018)	Nigeria Ahaotu *et al.* (2019)	Ethiopia Zeleke *et al.* (2020)	Iran Mohsenpour *et al.* (2020)
Egg weight (g)	38.14 ±0.35	48.21 ±0.34	35.9 ±0.55	40.7 ± 2.9
Egg length (mm)	49.24 ±0.13	50.31 ±0.3	47.0 ±0.59	48.36 ± 2.3
Egg width (mm)	37.42 ±0.10	40.06 ±0.1	36.1 ±0.39	38.05 ± 1.15
Shape index (%)	76.03 ±0.18	76.80 ±0.38	76.8 ±1.01	78.8 ± 3.69
Shell weight (g)	5.83 ±0.10	6.17 ±0.19	6.57 ±0.19	6.36 ± 0.95
Shell percentage (%)	15.23 ±0.19	12.84 ±0.38	18.3 ±0.71	15.60 ±1.79
Shell thickness (mm)	0.49 ±0.01	0.41 ± 0.01	0.73 ±0.05	0.71 ± 0.14
Egg surface area (cm^3)	Not recorded	67.48±0.47	Not recorded	58.73 ± 4.07

2013a; Ahaotu *et al.*, 2019), respectively, but higher (0.71 and 0.73 mm) by (Mohsenpour *et al.*, 2020; Zelleke *et al.*, 2020), respectively. In terms of eggshell surface area, Kgwatalala *et al.* (2013) reported that the egg surface area for the four varieties of helmeted guinea fowl (pearl, lavender, royal purple, and white) fall within the range of 56.2 and 68.9 cm reported by (Nowaczewski *et al.*, 2008) for the domestic and French guinea fowls, respectively. Nowaczewski *et al.* (2008) reported a highly significant and positive correlation coefficient of 0.989 between egg weight and egg surface area, which means the heavier the egg is, the more extensive the surface area, which is consistent with the largest egg surface area in the royal purple and the smallest surface area in the white variety. A study by Ahaotu *et al.* (2019) in Nigeria reported a higher egg surface area (67.48 cm3) for guinea fowl, in comparison with counterparts in a survey by Mohsenpour *et al.* (2020) in Iran, who found that average was (58.73 cm3). External egg quality characteristics of Guinea fowl under different tropical regions are presented in Table (1).

Internal egg quality

Kgwatalala *et al.* (2013) studied egg quality characteristics of four helmeted guinea fowl (pearl, lavender, royal purple, and white) kept intensively; they found that the royal purple variety had the highest albumin weight and also the lowest yolk weight and ratio percentage. In comparison, the white type had the lowest weight and ratio of albumin and the highest yolk percentage. The reported value for albumen weight was 22.9 g for guinea fowl eggs. Average values of albumen weight and ratio in studies (Vekić *et al.*, 2018; Mohsenpour *et al.*, 2020) were higher than those found in a study by (Zelleke *et al.*, 2020). The average value of albumen height investigated by (Vekić *et al.*, 2018) was similar to the report of (Kuzniacka *et al.*, 2004), who got an average value of albumen height of 5.6 mm. In contrast, height of albumen in the study of (Mohsenpour *et al.*, 2020) was 5.18 mm. On the other hand, (Alkan *et al.*, 2013; Zelleke *et al.*, 2020) found a lower value for albumen height (4.7 mm). Albumen quality is described primarily by Haugh units (HU). According to USDA's egg grading manual (USDA and Manual, 2000), eggs are classed into AA, A, and B grades. Grade AA is the highest quality, with a HU value above 72. Haugh units in the research of (Vekić *et al.*, 2018)for guinea fowl eggs indicated high egg quality, comparable with values of 82.1 found in white or 82.7 found in pearl variety by (Bernacki *et al.*, 2012), and was better than the value of 77.2 and 78.03 found by (Mohsenpour *et al.*, 2020; Zelleke *et al.*, 2020),and hence eggs are all in the highest quality category of grade AA. Nickolova (2009) got values of Haugh units above 95.61 during the laying season. A range of 12.4-13.5 g for yolk weight and 13.1-16.7 mm for yolk height was reported for guinea fowl eggs (Bernacki *et al.*, 2013b; Kgwatalala *et al.*, 2013), in close agreement with the results of the studies of (Mohsenpour *et al.*, 2020; Zelleke *et al.*, 2020). Average yolk height and diameter were 16.4 and 37.3 mm in a survey by (Bernacki *et al.*, 2013b), 15.7 and 15.20 and 39.83 mm found by (Banaszewska *et al.*, 2015). The average yolk index in studies (Vekić *et al.*, 2018; Mohsenpour *et al.*, 2020; Zelleke *et al.*, 2020) indicated the satisfying quality of analyzed eggs. Yolk color was darker (13.76) in a study by (Vekić *et al.*, 2018), similar to the findings by (Banaszewska *et al.*, 2015) who also found darker color (14.60), compared with the results of 9.69 (Bernacki *et al.*, 2012) or 8.80 in the study of (Mohsenpour *et al.*, 2020). Yolk color in the study of (Zelleke *et al.*, 2020) was 4.66, in a range of pale yellow yolk color. Yolk to albumen ratio was higher for guinea fowl eggs versus chicken genotypes (Zelleke *et al.*, 2020), which could be attributed to differences in the size and weight of eggs among the poultry genotypes. It has been noted that the yolk to albumen ratio tends to be greater in smaller eggs than in more giant eggs (Suk & Park, 2001). The Calculated mean yolk/albumen ratio in studies (Vekić *et al.*, 2018; Mohsenpour *et al.*, 2020; Zelleke *et al.*, 2020) was higher than the 0.55 observed by (Song *et al.*, 2000), or 0.51 in meat-type, found by (Nowaczewski *et al.*, 2008). A higher mean yolk/albumen ratio (0.68) was found by (Alkan *et al.*, 2013). Internal egg quality characteristics of Guinea fowl under different tropical regions is presented in Table (2).

Carcass yield and Meat Quality

Guinea fowl is the cheapest poultry meat to produce in some countries, particularly in Africa (Saina *et al.*, 2005). Guinea fowl meat is a good source of vitamins, niacin, and iron, and with a flavor comparable to game meat, it has been argued that guinea fowl merits a better price than chicken (Ajala *et al.*, 2007).Most studies on guinea-fowl meat quality were conducted in barn conditions (Bernacki *et al.*, 2012; Tufarelli & Laudadio, 2015), where as other studies focused on raising guinea fowl under semi-intensive 'free-range' farming conditions. Guinea fowls are characterized by relatively higher slaughter performance (Ebegbulem & Asuquo, 2018),good ratios of valuable parts in the carcass, and satisfactory sensory properties of meat

Table 2 – Internal egg quality characteristics of Guinea fowl under different tropical regions.

Trait	Bosnia and Herzegovina Vekić *et al.* (2018)	Ethiopia Zeleke *et al.* (2020)	Iran Mohsenpour *et al.* (2020)
Albumen quality			
Albumen weight (g)	20.23 ±0.24	18.5 ± 0.40	21.62 ± 2.78
Albumen percentage	52.69 ±0.26	51.5 ± 0.38	52.97 ± 4.56
Albumen height (mm)	5.67 ±0.04	4.78 ±0.14	5.18 ±0.55
Haugh unit	82.58 ±0.26	77.2 ±0.95	78.03 ±4.42
Yolk quality			
Yolk weight (g)	12.26 ±0.09	11.0 ±0.33	12.74 ±1.56
Yolk percentage	32.10 ±0.21	30.6 ±0.64	31.42 ±4.35
Yolk height (mm)	16.54 ±0.08	13.4 ±0.20	16.02±1.25
Yolk index	41.50 ±0.23	41.48 ±1.09	43.14 ±3.85
Yolk color (EMT-5200)	13.76 ±0.10	4.66 ±0.13	8.80 ±0.92
Yolk: Albumen ratio	0.61 ± 0.01	0.59 ±0.01	0.60 ±0.01

(Kyere *et al.*, 2020). The average slaughter age of 16 wks reported by earlier studies (Robinson, 2000; Embury, 2001; Saina *et al.*, 2005) is slowly invalidated as slaughter age in improved strains can be done at 12 weeks. Other studies recommend that guinea fowl intended for slaughter should rear for 14 weeks. Laudadio *et al.* (2012) slaughtered guinea fowls at 12 weeks and reported a bodyweight greater than 1900 g, an average daily gain of 23 g/d, feed intake of 66.9 g/d, and a food conversion ratio of 2.8. Bodyweight averaging 1300g was observed in guinea fowls aged nine weeks (Nahashon *et al.*, 2006). Bernacki *et al.* (2012) reported that the dressing percentage in guinea fowl varieties evaluated at14 weeks was similar. Ogah (2013)found that body weights for guinea fowls were less than 1.4 ± 0.09 kg. Musundire *et al.* (2017) reported that Guinea fowls outweighed chickens in terms of having higher body weight, carcass weight, cold dressed weight, and breast weight except for dressing percentage for both species (chickens and helmeted guinea fowls); proportions were comparable. A study by Ahaotu *et al.* (2019) in Nigeria and a survey by Zelleke *et al.* (2022) in Ethiopia reported a higher dressing percentage (75.4 and 73.8 %, respectively) for guinea fowl in comparison with a survey by Musundire *et al.* (2017) in Zimbabwe that found that average was (64.1 %) only. The same trend observed for the breast percentage trait. Some carcass characteristics of Guinea fowl under different tropical regions is presented in Table (3).

Carcass analysis techniques

There are several methods used to analyze carcass quality. These include physical and chemical analysis (Van Marle-Koster & Webb, 2000). Physical dissection involves cutting a carcass into commercially cut parts and weighing the parts to determine meat and bone yield. In poultry, commercially cut pieces include the thigh, breast, drumstick, wing, back, and neck (Oduguwa *et al.*, 2000). Chemical analysis was done to evaluate the nutritive value of the meat in terms of protein, fat, water, and minerals using the proximate analysis (AOAC, 2005). Organoleptic tests go further to determine the sensory attributes of the meat through the use of panelists. These include appearance, texture, and flavor. A study by Camas-Robles *et al.* (2020) in Mexico and a survey by Batkowska *et al.* (2021) in Poland reported higher carcass yield percentage (79.30 and 78.77 %, respectively) for guinea fowl in comparison with a study of Zelleke *et al.* (2022) in Ethiopia that found that an average of (73.8 %).

Meat pHvalue

The pH is an essential factor that affects the quality of meat. For example, a high pH shortens the shelf life of meat as it creates a more favorable environment for

Table 3 – Some carcass characteristics of Guinea fowls under different tropical regions.

Trait	Zimbabwe Musundire *et al.* (2017)	Nigeria Ahaotu *et al.*, (2019)	Ethiopia GetnetZelleke *et al.* (2022)
Slaughter weight (g)	920.8 ± 55.71	1110 ± 93	1308.3 ±86.58
Dressing (%)	64.1 ± 1.20	75.4 %	73.8 % ±1.19
Breast (%)	14.6 ± 0.51	23.5	21.4 ±0.59
Thigh (%)	Not recorded	11.8	12.0 ±0.58
Drum stick (%)	Not recorded	9.5	8.7 ±0.43

bacteria (Sarica *et al.*, 2019). The pH is one of the most critical physicochemical characteristics in meat since it is related to water holding capacity and color (Bosque *et al.*, 2020). The pH of broiler meat is the function of the amount of glycogen in the muscle before slaughter and the rate of glycogen conversion into lactic acid after massacre (Mir *et al.*, 2017). Kokoszyński *et al.* (2011) found mean breast- and thigh-meat pH values to be 6.1 and 6.4, respectively. Breast-meat pH values were between 5.72 and 5.76, and thigh meat pH values were between 5.79 and 5.81 (Laudadio *et al.*, 2012). The pH values ranged between 6.56 and 6.79 for breast meat and 6.85 and 7.30 for thigh meat (Sarica *et al.*, 2019). The pH ranged between 6.1 and 6.5 of guinea fowls breast and thigh meat (Kokoszyński *et al.*, 2011). However, the breast and thigh-meat pH values from 18-weeks-old male guinea fowl under the indoor system had higher importance of 6.8 and 7.3 (Sarica *et al.*, 2019) than in the survey of Zelleke *et al.* (2022). Generally, the study by Zelleke *et al.* (2022) shows that pH values for breast meat were lower compared to thigh meat. The survey byCamas-Robles *et al.* (2020) in Mexico found the pH of guinea fowls breast (6.03); a nearly similar value for pH is reported by Batkowska *et al.* (2021)in Poland, while, in the study by Zelleke *et al.* (2022) in Ethiopia a slightly higher value was found (6.2).

Water retention capacity

Water is one of the essential meat components in terms of the juiciness of fresh meat after cooking. Therefore, meat with a low water-holding capacity that loses large amounts of fluid during cooking may taste dry (Tlhong, 2008). Kokoszyński *et al.* (2011) found breast and thigh meat water-holding capacity values to range between 61.3% and 64.2% and 64.4% and 69.6%, respectively, while; Laudadio *et al.* (2012) reported values between 61.67% and 63.84%; and 67.25% and 69.61%, respectively, whereas, Sarica *et al.* (2019) measured higher values of between 72.20% and 75.12% and 75.76% and 77.80%, respectively, also, in addition, the water-holding capacity of breast and thigh meat was not significantly affected by the production system, slaughter age or sex. Camas-Robles *et al.* (2020) recorded a low value of water retention capacity in breast meat (14.47 %). Both meat water-holding capacity and drip loss are affected by meat pH, with pH values higher than 6.3, as in the study (Sarica *et al.*, 2019) is associated with a relatively dry meat surface and high water-holding capacity (Huff-Lonergan & Sosnicki, 2002), which may be related to pre-slaughter stress. Poltowicz (2012) reported that slow-growing broilers showed increases in pH and decreases in drip loss in line with slaughter age. Similarly, the study of Sarica *et al.* (2019) found that drip loss was significantly lower among older guinea fowl ($p<0.01$), neither production system nor sex had a significant effect on drip loss. Overall, the drip-loss values in this study (1.59% - 4.96%) are in line with those for guinea fowl (2.31% - 3.87%) that were reported by (Dahouda *et al.*, 2009).

Meat color

Meat color is one of the first traits noticed by consumers and an indicator of meat quality (Guan *et al.*, 2013). Computer vision system used to measure meat color for the breast muscle (Yam & Papadakis, 2004). The pH of the meat seems to have a strong influence on the color of the meat. Besides the meat pH value, meat color is correlated to the amount of haem-containing compounds such as myoglobin, hemoglobin, and cytochrome -c (Wideman *et al.*, 2016). Qiao *et al.* (2001) determined the border values for color of chicken breast muscle: lighter than normal ($L^* > 53$), normal ($48 < L^* < 53$) and darker than normal ($L^* < 48$). Lightness values reported for chickens and guinea fowls are higher than 42.3 ± 5.01 and 38.8 ± 1.46 (Wattanachant *et al.*, 2004) in major pectoral muscles of Thai indigenous and broiler chickens, respectively. The L* values found in the studyby (Musundire *et al.*, 2017) for lightness are considered in the normal range and not too pale (Woelfel *et al.*, 2002). Totosaus *et al.* (2007) reported that chicken breast meat could be divided into three classes ofcolor according to their instrumental L* values giving dark meat ($L^* < 47$), normal meat ($L^* = 47–50$), and pale meat ($L^* > 50$).According to this border value, the lightness color values in the studies (Camas-Robles *et al.*, 2020; Zelleke *et al.*, 2022) for the guinea fowl breast meat in Mexico and Poland tend to be darker than normal,whereas in the study by Batkowska *et al.* (2021) Ethiopia tends to be pale meat. Chicken breast meat generally appears to have a pink color, which is considered a desirable characteristic by consumers and has a normal color (Choo *et al.*, 2014).

The redness color in guinea fowl breast meat after cold storage for 24 h was higher than in other chicken genotypes (Bosque *et al.*, 2020). The redness values of breast and thigh meat of guinea fowl from the study by Zelleke *et al.* (2022) were higher and lower than the values reported by (Kokoszyński *et al.*, 2011; Sarica *et al.*, 2019), respectively, but similar to the study by (Laudadio *et al.*, 2012). A higher value of redness in guinea fowl meat compared to broiler chickens was

reported by (López-Pedrouso *et al.*, 2019). Although the genetic differences might have contributed to the variation in breast and thigh meat color, the tendency for guinea fowl meat to be darker or redder under an intensive production system might be due to slower growth and higher physical activity in the experimental pens.The differences in redness values observed among poultry species are attributed to genetic traits (Souza *et al.*, 2011) and muscle composition. With the increase in age, there was a decrease in lightness due to thicker fillets in older and heavier birds which results in a darker color, similar to findings by (Fanatico *et al.*, 2005) in slow-growing broiler genotypes. A study by Camas-Robles *et al.* (2020) in Mexico reported that the redness color of guinea fowl breast meat (Pectoralis major) was higher compared to the values reported by Batkowska *et al.* (2021) in Poland & Zelleke *et al.* (2022) in Ethiopia.

Higher yellowness in chickens due to the higher fat content of the breast muscle than in guinea fowls is consistent with the study results by (Musundire *et al.*, 2017). A higher yellowness in adult birds than in growers is consistent with the work of (Fanatico *et al.*, 2005), who reported yellower carcasses in foraging broilers than in indoor reared broilers. Increased time of access to forage by the chickens and guinea fowls results in the yellower flesh of the breast as birds ingest more pigments from plants. The female breast meat was more yellow than males, similar to findings by (Souza *et al.*, 2011), where male broilers had lower yellowness values than females. The higher amount of accumulated fat in females than males contributes to the more yellow color of meats (Kokoszyński *et al.*, 2011). Breast meat of female and male did not differ in lightness and redness, similar to findings by (Souza *et al.*, 2011). A survey by Zelleke *et al.* (2022) in Ethiopia reported higher yellowness (12.2) for guinea fowl breast meat (Pectoralis major) in comparison with a survey by Batkowska *et al.* (2021) in Poland that found that the average was (10.26), whereas, in the study by Camas-Robles *et al.* (2020) in Mexico the lowest value was found (7.11). Breast meat (Pectoralis major) quality of guinea fowl in different tropical regions is presented in Table (4).

CONCLUSION

Finally, the results of the current study showed that external egg quality characteristics, mainly (egg weight, shell percentage, and shell thickness), and internal egg quality traits, mainly (albumen weight, haugh unit, yolk height, and yolk color) of Guinea fowl differed under different tropical regions. Concerning carcass characteristics, a clear difference is observed in dressing percentage and breast percentage of Guinea fowl invarious tropical areas. A similar trend was observed for the meat color.

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Table 4 – Breast meat (Pectoralis major) quality of guinea fowl under different tropical regions.

Parameters	Mexico Camas-Robles *et al.* (2020) 14 wks (5 males)	Poland Batkowska *et al.* (2021) 14 wks (8 birds)	Ethiopia GetnetZelleke *et al.* (2022) 20 wks (3 males)
Carcass yield, %	79.30 ±1.27	78.77±0.92	73.8 ±1.19
Water retention capacity, %	14.47 ±0.01	Not recorded	Not recorded
pH	6.03 ± 0.04	5.99 ±0.21	6.2 ±0.03
Meat Color			
Luminosity "Lightness"	45.04 ±0.89	54.47 ±0.97	47.2 ±2.08
Redness	14.95 ±0.25	2.18 ±0.41	5.3 ±0.52
Yellowness	7.11 ±0.29	10.26 ±0.56	12.2 ±0.58

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