Journal of Animal &Plant Sciences, 2013. Vol.19, Issue 2: 2908-2922
Publication date 2/10/2013, http://www.m.elewa.org/JAPS*; ISSN 2071-7024*

Nutritional quality of meat from local poultry population of *Gallus gallus* species of Benin

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Key words: Benin, free range, indigenous chicken, chemical composition.

1 SUMMMARY

Local chicken populations of Benin include North, South, Holli, Fulani and Sahoue ecotypes. This study assesses the nutritional quality of their meat. Two groups of 26 chickens of each ecotype were reared under free range or confinement breeding systems, and slaughtered when 20, 24 and 28 weeks old. Breast and thigh-drumstick meats were used for chemical and physico-chemical parameters composition analysis. The results showed that the highest dry matter and protein contents were recorded in Holli ecotype (P<0.01), whereas the highest fat content was found in Fulani ecotype. The free range chickens showed the highest protein content (P <0.001), whereas chickens from confinement breeding had the highest fat content (P<0.05). Protein content was higher in breast than in thigh (P <0.001), while dry matter, ash and fat contents were higher in thigh meat than in breast meat (P <0.001). The dry matter content decreased with age (P <0.001), while the fat content increased (P<0.01). The highest protein content of thigh and breast were obtained between 20 and 24 weeks old. It can then be conclude that indigenous chicken meat is better at 24 weeks of age.

2 INTRODUCTION

In Sub-Saharan Africa, indigenous avian species are mainly exploited by rural families under traditional breeding system (FAO, 2004) and represent a means of livelihood for households

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(FAO, 2002; Ahuja and Sen, 2007; Ali *et al.*, 2011). Therefore, family poultry contribute considerably to ensure food security and food safety to the rural pro-poor population (Mankor, 2009). Domestic local poultry (*Gallus gallus domesticus*) represents the main avian genetic resources in West Africa with about 80 % of total poultry population (FAO, 2011). Generally, the indigenous poultry are a slow-growing type with a low carcass weight (Missohou *et al.*, 2002, FAO, 2004) and are reared mainly for meat production and secondarily egg production. In Benin, the indigenous chickens represent 81.3 % of the national poultry flock (CountryStat, 2012). In spite the importance of poultry flock, local poultry meat production remains below the consumer demand. This shortage involves the increasing of meat imports (2.5 times from 2000 to 2010 accordingly to CountrySTAT, 2012). Despite the low domestic production of local chickens (2,020 tons in 2010), local chicken meat is more appreciated by consumers in comparison with imported chicken meat (Houéssionnon, 2011). In Benin in 1963, the exotic rooster strains were introduced in family poultry farms to improve local chicken performances by crossing. However, the crossings process had not been accepted by Holli, Sahoue and Fulani ethnic groups. Currently, this crossing process creates genetic erosion within the local poultry population of the others ethnic groups who were agree. However, the reluctance of populations of Holli, Sahoue and Fulani ethnic groups had promoted conservation and perpetuation of varieties or breed of chickens owned by these ethnic groups, which bear now their name. The local population of poultry of the species *Gallus gallus* of Benin is ever since composed of various ecotypes among which are North, South, Holli, Fulani or Peuhl and Sahoue ecotypes (Bonou, 2006). These indigenous poultry have a remarkable heterogeneity in phenotypical traits (Youssao *et al.*, 2007) and polymorphism trait (Youssao *et al.*, 2009). Several studies were carried out on carcass traits of these local genetic types (Youssao *et al.*, 2009; Youssao *et al.*, 2010; Youssao *et al.*, 2012; Tougan *et al.*, 2013a). The breeding mode and slaughter age effects on carcass composition (Tougan *et al.*, 2013a) and technological meat quality (Tougan *et al.*, 2013b) of these five local chicken populations of Benin showed important differences in meat quality. However, no data is available on chemical composition and nutritional quality of Benin local chicken meat. This work assesses the chemical composition of local chicken meat in relation with their breeding system, type of muscle and slaughter age.

3 MATERIAL AND METHODS

3.1 Area of study: The study was conducted simultaneously at the experimental farm of "Ecole Polytechnique d'Abomey-Calavi (EPAC)" and at the free range poultry breeders located in Abomey-Calavi in Atlantic Department. Situated at latitude of 6° 27' north and at a longitude of 2° 21' east, the Commune of Abomey-Calavi covers an area of 650 km² with a population of 307,745 inhabitants (INSAE, 2010). This area exhibits climatic conditions of sub-equatorial type, characterized by two rainy seasons with an uneven spatial and temporal distribution of rainfall: major (from April to July) and minor (from September to November). These two seasons are separated by a dry season. Average rainfall is close to 1,200 mm per year. The monthly average temperatures vary between 27 and 31°C and the relative air humidity fluctuates between 65%, from January to March, and 97%, from June to July.

3.2 Chicken and management: The chickens used in this experiment were from breeding animal of 10 hens and 3 cocks of each genetic type (North, South, Holli, Fulani and Sahoue), reared in confinement at the experimental farm of EPAC. Eggs from each genetic type were collected and incubated. After hatching, the chicks were weighed, identified by a sterile numbered ring fastened to the wing, reared in confinement

breeding system until 12 weeks, and then allocated into two groups. Only the males were used in this study. Group 1 composed of 26 cockerels of each genetic type was reared under improved breeding system and the group 2 composed of 26 cockerels of each genetic type was bred in free-range breeding system at local chicken breeders targeted in each agro-ecological area.

3.3 Characteristics of traditional breeding system: The birds were let scavenge during the day but housed at night in rudimentary shelters (traditional henhouse made of mud, straw or wicker), or kept outside on any support that could serve as a perch. The feeding is not rational and the birds fed themselves by gleaning, but some grain supplement was distributed to birds occasionally (Tougan *et al*., 2013a). Their diet was composed of energetic elements (kitchen waste, bran ...), vitamins (green fodder, sprouted grains ...), minerals (salt and pounded shells) and protein from termites and leguminous plants (Tougan, 2008; Youssao *et al*., 2013). Water was distributed in rudimentary watering tank. Various discarded containers were often used for drinking. In this type of farming, no health follow-up or prophylactic standards were applied (Tougan *et al*., 2013a).

3.4 Characteristics of improved breeding system: In confinement breeding system, the birds were bred on wood shavings litter in buildings of California type. Brooders, feeders, drinkers ... were the livestock equipment used. The number of these devices depended on the number of birds in the henhouse. Chickens were fed successively with the starting diet (2,880 ME Kcal/kg of feed and 18% of crude protein); growing diet (2,969 ME Kcal/kg of feed and 18% crude protein) and laying diet (2,800 ME Kcal/kg of feed and 20% of crude protein) according to values gave by Youssao *et al.* (2009). The starting diet was used from the hatching to the age of 2 months and the growing diet from 2 month old to the point of laying (22 weeks). From the start of egg production to the end of the experimentation, the diet for layer was used. The chickens were fed *ad libitum*. Feed transitions between the different growth periods were done during three days between the different growth periods by gradual incorporation to the previous diet of the respective proportions of 25, 50 and 75 % of the new diet.

Chicks were raised in pens built according to the standards of tropical breeding as described by Tougan *et al.* (2013b). Supplementary heat was supplied electrically to the birds during the first three weeks. Shutters are punctually opened according to the pen temperature. To stimulate feed intake, lighting were maintained throughout the night in the house. All animals were treated for internal parasites with Anticox® (Sulfamidine, Laprovet France, 4 g/20 L of water during 3 days) and Alfamizol® (levamisol, Alfasan Holand, 1g/1,5L of water per day) and vaccinated against main diseases such as avian chronic respiratory disease, coccidiosis, Newcastle disease, Gumboro (Infectious Bursal Disease), fowl pox, Marek's disease, avian infectious bronchitis, , small pox and vitamins were supplied. The materials were cleaned every day. A monthly sample of feces were analyzed in order to follow the deworming efficiency and to make sure that the coccidia and gastro-intestinal parasites did not affect the growth performances of the birds. Between two bands, the henhouses were disinfected and left unoccupied for one to two weeks (all in all-out policy). At the entrance of each building, a footbath which consisted of cresyl solution was installed to disinfect feet.

3.5 Slaughtering process: In each ecotype, 13 birds whose live weight was higher than the average live weight of the group and 13 birds whose live weight was weaker than the average live weight of the group were selected. A total of 26 cocks of each breeding mode were selected per genetic type for slaughtering. The selected chickens were weighed and bled after 16 hours of deprived of water and feed (Tougan *et al*., 2013a). The chickens were bled by section of the jugular vein and then scalded in hot water (70-80 ° C) and plucked manually. Then, they were eviscerated and heart, kidney, crop and intestines were taken off. The samples of breast and thigh-drumstick were collected to determine the chemical composition of meat.

3.6 Data collecting

3.6.1 Nutritional quality of breast and thigh-drumstick meat: The frozen samples of the right breast and the right thigh-drumstick were dissected into small pieces and homogenized in a blender at -10°C. Moisture, protein, fat, and ash contents of breast and thigh-drumstick meat samples were determined following the standard procedures

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(AOAC, 2000). Moisture content was determined gravimetrically (Corthinas, 2004; Oluwatosin et *al.,* 2007) by drying 6 g of meat at 105°C accordingly to the NF V 04-401 French standards method. Each value was an average of 2 measurements. Crude protein was determined by Kjeldahl method according to the NF V 04-407 norm and using a Kjeltec Auto Sampler System 1035 Analyzer (Foss, Benelux). Each analysis was repeated twice. The total ash content was determined according to the NF V 04-404 French standard method. About 6 g of samples were ashed in an oven maintained at 550°C to determine ash content and was repeated twice. The fat content was determined by Soxhlet method according to the NF V 04-402 standard ISO 1443: 1973. Each analysis was repeated twice-using petroleum ether at 40-60°C.

3.6.2 Statistical analysis: The data collected on nutritional quality of the meat of the different genetic types of chicken were analyzed with the software SAS (Statistical Analysis System, 2006). For the analysis of variance, a fixed effects linear model was adjusted to the data and includes the fixed effects of genetic type, breeding system, muscle type and slaughter age. The interaction between genetic type and age and between breeding system and age were significant and taken into account in the model of variance analysis. The mathematical expression of this model is as follows:

$Y_{ijklm} = \mu + E_i + BM_j + M_k + Age_l + E*M_{ik} + M*Age_{kl} + e_{ijklm}$, with:

- Y_{ijklm}: mean performance of individual m, of ecotype i, of the breeding system j, of the muscle k and of slaughter age l.
- μ: average performance;
- E_i: fixed effect of ecotype i (Holli, Fulani, Sahoue, North and South) ;
- BM_j: fixed effect of breeding mode j (traditional and improved);
- M_k: fixed effect of muscle k (thigh-drumstick and breast).
- Age_l: fixed effect of slaughter age l (20, 24 and 28 weeks);
- $E*M_{ij}$: Interaction between ecotype i and muscle j;
- $M*Age_{kl}$: Interaction between muscle k and slaughter age l;
- e_{ijklm}: Effect of random residual average performance of the individual m, of ecotype i, of the breeding mode j, of the muscle k and slaughter age l.

The F test was used to determine the significance level of each effect in the model. Means were compared two by two by the Student's t test. The interactions between breeding mode and muscle and between ecotype and breeding mode were not significant.

4 RESULTS

4.1 Effect of the ecotype on nutritional quality of meat: The nutritional meat quality varied according to the genetic type (Table 1). Overall, the contents in dry matter, organic matter, protein and fat were affected by genetic type ($P < 0.01$), whereas total ash content did not differ among genotypes ($P > 0.05$). Indeed, the dry matter content of Holli ecotype chickens meat was similar to those of North ecotype ($P > 0.05$), but significantly higher ($P < 0.001$) than the one recorded in Fulani, Sahoue, and South ecotype chickens. The lowest content of dry matter of the meat was recorded in South ecotype chickens ($P < 0.01$; table 1). No significant difference was observed among total ash content (0.97 to 0.99 %) of the five genetic types ($P > 0.05$). The fat content of the meat of North (2.06 %) and Fulani (2.09 %) ecotype was similar ($P > 0.05$), but more important than the one of Holli (1.83 %), Sahoue (1.99 %) and South (1.83%) ecotype chickens meat ($P < 0.01$; table 1). The highest protein content (20.91 %) of the chicken meat were recorded in Holli ecotype ($P < 0.001$), whereas no significant difference was observed between the protein content of North, Fulani, Sahoue and South ecotype chickens meat which varied from 20.28 % to 20.53 % ($P > 0.05$).

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Table 1: Effect of genetic type on nutritional parameters of indigenous chicken meat of Benin

Variables	Chicken ecotypes					RSD	Test of Significance
	Holli	North	Fulani	Sahoue	South		
Dry matter (% FM)	23.72a	23.55ab	23.37b	23.38bc	23.07c	0.81	**
Total ash (% FM)	0.98a	0.98a	0.98a	0.99a	0.97a	0.12	NS
Fat (% FM)	1.83b	2.06a	2.09 a	1.99ab	1.83b	0.41	**
Protein (% FM)	20.91a	20.53b	20.32b	20.41b	20.28b	0.78	***

FM** : Fresh matter;* ***NS:** No Significant;* **:** P<0.01 ;* ****** :** P<0.001. The means of the same line followed by different letters differ significantly with the threshold of 5%.* RSD: Residual Standard Deviation.

4.2 Effect of type of muscle (*Breast vs thigh-drumstick*) on nutritional quality of meat : The type of muscle had affected (P<0.05) all the meat quality parameters measured in the present study (Table 2). The protein content of raw breast meat was significantly higher (P<0.001) than those of the thigh(21.3% *vs* 19.7%) . In return, thigh-drumstick meat were significantly higher than those of breast meat (P<0.001) for the contents in dry matter (23.1% *vs* 23.7%), ash (0.96% *vs* 1%) and fat (2.97 *vs* 0.95).

4.3 Effect of the breeding mode on nutritional quality of meat: The breeding mode influenced only fat and protein contents (P<0.001). Indeed, the chickens reared under free range breeding system had total protein content higher than the chickens bred in confinement breeding system (20.8 % *vs* 20.2 % of raw meat; P<0.001), whereas birds of improved breeding had the higher fat content (2.2 % *vs* 1.8 % of raw meat; P<0.05). No significant difference was observed between the dry matter and ash contents, of breast and thigh among the breeding modes (confinement system *vs* free range system) (table 2).

4.4 Effect of slaughter age on meat nutritional quality: The slaughter age affected meat quality. Overall, except the total fat content, all others meat quality traits varied significantly according to the slaughter age. Indeed, the dry matter content decreased with the slaughter age. The lowest dry matter content was obtained at 28 weeks old (P <0.001) while the highest content was recorded at the age of 24 weeks. The same trend was observed for protein content (P <0.001) with the lowest value recorded at 28 weeks old. Nevertheless, the fat and moisture contents of raw meat increased with age, with the values measured at 28 weeks old significantly higher than those obtained at 20 and 24 weeks old (P<0.001; table 2).

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Table 2: Variation of nutritional parameters of meat by type of muscle, breeding mode and slaughter age

Variables	Muscle		Breeding mode		Ages at weeks			RSD	Effect of		
	Breast	Thigh-drumstick	Free range	confinement	20	24	28		muscle	breeding mode	age
Dry matter (% FM)	23.12a	23.72b	23.49a	23.35a	23.63a	23.67a	22.95b	0.81	***	NS	***
Total ash (% FM)	0.96a	1.00b	0.98a	0.98a	0.99a	0.99ca	0.96bc	0.12	*	NS	NS
Fat (% FM)	0.95a	2.97b	1.76a	2.16b	1.72a	1.96b	2.20c	0.41	***	***	***
Protein (% FM)	21.23a	19.76b	20.76a	20.23b	20.92a	20.72a	19.83b	0.78	***	***	***

FM** : Fresh matter;* ***NS:** No Significant;* *:** P<0.05;* ****** :** P<0.001. The means of the same line followed by different letters differ significantly with the threshold of 5%.*
RSD: Residual Standard Deviation.

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4.5 Interaction between ecotype and type of muscle on nutritional quality of meat: In Holli ecotype, protein contents of breast meat were significantly higher than those of the thigh (P<0.001), whereas the contents in dry matter, ash and fat of thigh-drumstick meat were significantly higher (P<0.001) than those of breast meat (table 3). In North ecotype chicken, protein contents of breast meat were more important than those of the thigh (P<0.001). Meanwhile, the dry matter and fat contents of thigh-drumstick meat were significantly higher than those of breast meat (P<0.01; table 3). However, the ash content of North ecotype chicken meat did not vary significantly depending on the type of muscle. Protein contents of breast meat of Fulani ecotype chicken were significantly higher than those of the thigh (P<0.001); while the dry matter and fat contents of thigh-drumstick meat were significantly higher than those of breast meat (P <0.001). No significant difference was found between the ash content of thigh and breast meat in Fulani chicken (table 3). About Sahoue ecotype chicken, protein contents of breast meat were significantly higher than those of the thigh (P <0.001), whereas the contents of dry matter, organic matter and fat of thigh-drumstick meat were significantly higher than those of breast meat (P<0.001). Nevertheless, the ash contents of thigh and breast meat were similar in Sahoue ecotype chicken (table 3). In South ecotype chicken, protein contents of breast meat were significantly higher than those of the thigh (P<0.001). In return, the contents in dry matter and fat of thigh-drumstick meat were significantly higher than those of breast meat (P<0.001). Nevertheless, the ash content of South ecotype chicken meat did not vary significantly depending on the type of muscle (P>0.05; table 3).

4.6 Interaction between muscle and age on nutritional quality of meat: In thigh meat, the contents of dry matter, ash and protein decreased with the slaughter age. The lowest values were obtained when 28 weeks old (P <0.05). Nevertheless, the fat content of thigh meat when 28 weeks old were higher (P<0.05) than the values obtained when 20 and 24 weeks old (table 4). In breast meat, the dry matter and protein contents decreased with the slaughter age (P<0.05); while the fat content of thigh meat increased with age (P<0.05; table 4).

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Table 3: Interaction between ecotype and type of muscle on nutritional parameters of meat

Variables	Ecotype Holli		ANOVA	Ecotype North		ANOVA	Ecotype Fulani		ANOVA	Ecotype Sahoue		ANOVA	Ecotype South		ANOVA	RSD
	Breast	Thigh		Breast	Thigh		Breast	Thigh		Breast	Thigh		Breast	Thigh		
Dry matter (% FM)	23.44a	24.02b	**	23.21a	23.90b	**	23.12a	23.64b	*	23.03a	23.74b	**	22.84a	23.32b	*	0.81
Total ash (% FM)	0.94a	1.03b	**	0.97a	1.01a	NS	0.97a	1a	NS	1.02a	0.97a	NS	0.95a	0.99a	NS	0.12
Fat (% FM)	0.93a	2.75b	***	0.96a	3.17b	***	1.02a	3.17b	***	1.05a	2.94b	***	0.83a	2.84b	***	0.41
Protein (% FM)	21.60a	20.23b	***	21.33a	19.75b	***	21.16a	19.49b	***	20.99a	19.83b	***	21.08a	19.50b	***	0.78

FM** : Fresh matter; **NS:** Non-Significant; ***:** P<0.05; *:** P<0.01 ; ***** :** P<0.001. The means of the same line followed by different letters differ significantly with the threshold of 5%.* **RSD:** Residual Standard Deviation. ANOVA: analysis of variance (test of Significance).

Table 4: Interaction between type of muscle and age on nutritional parameters of meat

Variables	Thigh at age of			Breast at age of			RSD
	20 weeks	24 weeks	28 weeks	20 weeks	24 weeks	28 weeks	
Dry matter (% FM)	23.93a	24.04ab	23.19b	23.35a	23.31b	22.72b	0.81
Total ash (% FM)	1.02a	1.01a	0.97b	0.96a	0.99a	0.95a	0.12
Fat (% FM)	2.60a	2.97b	3.32c	0.80a	0.95ab	1.10b	0.41
Protein (% FM)	20.60a	20.06a	18.96b	21.50a	21.39a	20.71b	0.78

FM** : Fresh matter; **NS:** No Significant; *:** P<0.01. The means of the same line followed by different letters differ significantly with the threshold of 5%.* **RSD:** Residual Standard Deviation.

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5 DISCUSSION

5.1 Effect of ecotype on meat quality: Dry matter content in meat of Holli ecotype is similar to the one of North ecotype chicken, but significantly higher than those recorded in chickens of Fulani, Sahoue, and South ecotypes. No significant difference is observed among the total ash content of the 5 genetic types. The similarity observed for dry matter in meat of Holli and North ecotype of chickens confirm the results of Fanatico *et al.* (2005) who showed that dry matter and ash contents were not affected by genotype in slower-growing broiler genotypes grown with and Without Outdoor Access. Similarly, the results of Latter-Dubois (2000) showed no significant difference between the dry matter and ash of the breast meat (with skin) among 5 hybrid lines of slow medium and fast growing chickens. Nevertheless, Holcman *et al.* (2003) reported that the dry matter content of breast and leg muscle of Prelux chickens was higher than in Ross chickens.

In the present study, the fat content of the meat of North and Fulani ecotype chickens are similar, but more important than the one of the meat of Holli, Sahoue and South ecotypes chickens. Therefore, until the age of 28 weeks, the local chicken carcass is still lean with very low intramuscular fat content and confirms observations of Youssao *et al.* (2009) and Youssao *et al.* (2012) on chicken of North and South ecotypes. The fat content was within those reported (0.68 - 2.78 %) in different strains of broiler by Aberni and Bergoglio (2001) and Qiao *et al.* (2002), and those found (0.51-2%) by Wattanachant *et al.* (2004) in meat from naked-neck chicken and Thai indigenous chicken. However, these results are lower than the fat content of 7% found by Holcman *et al.* (2003) in breast and thigh meat with skin of Ross 208 and Prelux-bro broiler chickens of Slovenia, 3.11% reported by Chuaynukool *et al.* (2007) on breast muscle of Thai indigenous chicken, and from 9 to 12% recorded by Mourao *et al.* (2008) in Ross 350 broiler chickens. This considerable variability in the fat content must be related to the different sampling methods. Some authors analyzed the content of fat in muscle while others analyzed it in muscle with skin, so that subcutaneous fat was included or not and therefore can affect fat content of meat. The variability of fat content of chicken meat among genotype was also reported by Longeran *et al.* (2003), who found that breast meat without skin from fast-growing broilers had higher lipid content than from slow-growing ones. Furthermore, Havenstein *et al.* (2003) showed that modern 2001 Strain of chicken had more fat content than *older 1957 Strain* of chicken. In Thaïland, Jaturasitha *et al.* (2008a), Wattanachant *et al.* (2004), Wattanachant and Wattanachant (2007), and Chuaynukool *et al.* (2007) reported that genotype of chickens plays an important role in carcass fatness and meat quality. However, Fanatico *et al.* (2005) demonstrated that fat content was not affected by genotype. Moreover, Latter-Dubois (2000) found no significant differences in fat among the fast-, medium-, and slow-growing genotypes. Furthermore, the highest protein content (20.91%) of the chicken meat (including thigh and breast) is recorded in Holli ecotype in our study. This significant effect of genotype on the meat quality is also reported in several studies carried out by Brunel *et al.* (2006), Oluwatosin *et al.* (2007) and Jaturasitha *et al.* (2008b). In Nigeria, the study carried out by Oluwatosin *et al.* (2007) reveals significant effect of genetic factors on the nutritional quality of the breast and thigh of four strains of exotic chickens and local chickens of Nigeria. Their study showed that meat of local chickens of Nigeria was nutritionally better than the one of exotic cockerels. More exactly, they found that indigenous chickens of Nigeria had the lowest fat content and the highest protein and minerals contents comparatively to the exotic one. Similarly, in Thaïland, Jaturasitha *et al.* (2008b) observed that the indigenous chickens of Thaïland were nutritionally better than the improved layer breeds and their crossbred. These results confirm the report of Brunel *et al.* (2006) who showed that protein and lipid rates of chicken meat depend on the genetic type. However, an important variation exists among published nutritional data on breast and thigh-drumstick meat of chicken. Our results on moisture, dry matter, fat and proteins contents in breast and thigh-drumstick meat are within the limits reported by Demby and Cunningham (1980) in chicken meat. These authors reported that the water content of raw chicken meat varied from 60.4 to 75.4 %, the protein content from 17 to 23.3 %, the fat content from 1.0 to 17.4 % and the ash

content from 0.7 % to 3.6 %, with averages of 71.1, 19.8 and 7.5 %, respectively, which left 1.6 % for ash. The values obtained for dry matter, protein and ash in this study are slightly lower than those recorded by Franco *et al.* (2012) who reported that water content, protein and ash value were 74.2%, 22.97% and 1.32% respectively in broiler strain Mos and 73.88%, 23.68% and 1.27% in broiler strain Sasso T-44; they are also weaker than those reported by Konrad and Gaal (2009) on the Hungarian Yellow chickens and Bogosavljevic-Boskovic *et al.* (2010) on broilers.

Many variables such as breed, feed, age, system of production, sex, processing and type of meat that can affect nutritional values may account for a large part of the wide range in data (Holcman *et al.*, 2003).

5.2 Effect of breeding mode on nutritional quality of meat: The free range chicken meat has higher protein than the confinement chickens, whereas chicken meat from confinement system had higher fat content. Therefore, the free range poultry meat nutritional quality is interesting because it allows not only obtaining less fatty meat but also and consequently, more rich in protein. Similar results were obtained by Castellini *et al.* (2002), Konràd and Gaàl (2009), and Bogosavljevic-Boskovic *et al.* (2010) when comparing organic production system to conventional production system on broiler chickens. Indeed, Castellini *et al.* (2002) observed that a fat content of 2.37 % was observed for chicken from conventional production system *vs* 0.74 % for the organic chickens at 81 days old. Our results also confirm the report of Brunel *et al.* (2006) who showed that fat content variation can be tied to production system since the organic system reduces by three times the lipid content of chicken breast meat. Moreover, Mikulski *et al.* (2011) observed in slow-growing and fast-growing chickens raised with and without outdoor access that the breast meat of free-range chickens contained significantly more protein than the breast meat of chickens raised without outdoor access. Therefore, the main effect of outdoor access may be to make the meat less fatty and more nutritious in chickens.Holcman *et al.* (2003) reported that dry matter content of breast and leg muscle of Prelux and Ross chickens was higher in chickens from extensive indoor rearing in comparison to free range system. Similarly, Mikulski *et al.* (2011) observed in chickens raised with and without outdoor access that the breast meat of free-range chickens contained significantly more dry matter than the breast meat of chickens raised without outdoor access. These reports differ from the present result indicating that no difference was observed for dry matter content according to the production system. However, Fanatico *et al.* (2005) revealed that breast dry matter (%), fat (%) and ash (%) were unaffected by production system.

5.3 Effect of type of muscle on nutritional quality of meat: Moisture and protein contents in breast meat are significantly higher than those in thigh. The dry matter, , ash and fat contents of thigh-drumstick meat are significantly higher than those of breast meat. These differences in the quality of meat depending on the type of muscles are also reported in the literature (Latter-Dubois, 2000, Oluyemi and Roberts, 2000, Berri *et al.*, 2007 and Jaturasitha *et al.*, 2008b). As observed in this study, Jaturasitha *et al.* (2008a) found that protein content of breast meat of Thai indigenous chickens varies between 23.6 and 24.8% against 20.1 and 21.7% for thigh meat. Latter-Dubois (2000) obtained significant differences between the content in dry matter and total ash of the breast and the thigh (with skin) in 5 hybrid lines of chickens. Generally, chicken breast muscle and thigh had the highest proportion of meat and vary in their nutrients composition based on functional roles they perform within the chicken body (Oluyemi and Roberts, 2000), with the breast meat more nutritious than thigh. This muscle effect on meat quality confirm the results obtained by Latter-Dubois (2000), Beri *et al.* (2007), Jaturasitha et *al.* (2008), Konrad and Gall (2009) and Bogosavljevic-Boskovic *et al.* (2010), in chicken meat. According to the study of Holcman *et al.* (2003), breast muscle with skin contained more protein, ash, less dry matter, and fat than leg muscle with skin.

5.4 Effect of slaughter age on nutritional quality of meat: In the current study, the slaughter age affects the chemical composition of meat. The dry matter content is constant from 20 weeks to 24 weeks old before decreasing slightly at 28 weeks. Our result complies with the findings obtained in meat of Padovana breed of chicken slaughtered at 150 and 180 days old by De Marchi *et al.* (2005) who reported no significant effect of age on dry

matter content. Similarly, Diàz *et al.* (2010) found that the dry matter content of drumstick meat of Spanish indigenous chicken, Sasso T-44 and Sasso X-44 breeds was similar from 20 weeks to 24 weeks old, but decreased significantly from 24 to 40 weeks old. However, in Thailand, the studies of Wattanachant and Wattanachant (2007) and Wattanachant (2008) on changes in composition, structure, properties of muscle protein and meat quality of Thai indigenous chickens during growth from 6 to 24 weeks old reported that moisture content in muscle decreased respectively from 77.8 to 71.6%. Similarly, our result for dry matter content is not in agreement with the one recorded in *2001 strains* broilers meat by Havenstein *et al.* (2003) that revealed that dry matter content increased from 33.8% at 43 days old to 36.8% at 71 days old. Baéza *et al.* (2012) observed that moisture content decreased from 74.3% at 35 days old to 73.1% at 63 days old in heavy line of broilers meat. This variation of age effect on dry matter content can be associated to the difference in the slaughter age of birds, their live weight at slaughtering, the genotype and others factors non-investigated in the present study. Indeed, birds used in most of the studies cited are quite fast growing genotype and slaughtered at young age, and then may be not representative of the indigenous ecotypes currently used for our study. In the current study protein content decreases when age of birds increases, with the lowest value recorded at 28 weeks old. Our findings are in line with the reports of Diàz *et al.* (2010) who showed that protein content of meat of Spanish indigenous chicken breeds decreased respectively from 21.9 to 20.7% in breast, and from 18.6 to 15.6% in drumstick when bird age increased from 20 to 40 weeks. The same observation was made by Suchy *et al.* (2002) on chemical composition of muscles of hybrid broiler chickens during prolonged feeding. However, our findings were different from the reports of Baéza *et al.* (2012), Wattanachant (2007, 2008), and De Marchi *et al.* (2005) who found surprisingly that protein concentration increased with age. The fat content increases significantly with the slaughter age. These observations are similar to those made by Smith *et al.* (2002) on broiler breast meat. Our result is also in agreement with the report of Diàz *et al.* (2010) in Spanish indigenous chicken. These authors found that total lipid content in chicken increased significantly from 0.65 to 0.86% from 20 to 36 weeks old. Similarly, Baéza *et al.* (2012) reported in heavy line broiler chicken that fat content was of 1.29% at 35 days old to 1.92% at 56 days old. Zanusso (2002) reported that lipid levels increased regularly in breast and thigh muscles of chickens from 6 to 22 weeks old.

6 CONCLUSION

The results of the present study on the nutritional quality of breast and thigh meat of the 5 indigenous chicken populations of Benin bred under confinement or traditional free range system reveals that the contents of dry matter, moisture protein and fat are affected by genetic type. The meat of Holli chicken is more rich in protein and less fatty than the four others ecotypes. The thigh and breast meat of chicken bred under traditional free range system have the higher protein content and lower fat content than chicken from improved breeding system. Moreover, the chemical composition of our indigenous chicken meat differs among type of muscle with the highest protein content recorded in breast, while thigh have recorded the highest fat content. The highest protein content of thigh and breast meat is obtained between 20 and 24 weeks old. The ideal slaughter age of chickens of Holli, North, Fulani, Sahoue and South chickens ecotypes is then 24 weeks. Furthermore, since the fat content increased with age and differed among genotype, breeding system and type of muscle, it would be interesting to determine in further study the fatty acids profile of meat of local poultry population of *Gallus gallus* species of Benin in relation with the breeding system and the type of muscle to assess their value for human health.

7 ACKNOWLEDGEMENTS

The authors thank the "Commission Universitaire pour le Developpement", Animal Sciences Unit and Analytical Chemistry Laboratory from Gembloux Agro-Bio Tech (University of Liege, Belgium) for giving all types of support in conducting this study.

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