International Journal of Basic and Applied Chemical Sciences ISSN: 2277-2073
Online, Open Access International Journal, Available at http://www.cibtech.org/jcs.htm
2021, Vol.11, pp.1-14/Djakalia et al.
***Research Article** (Open Access)*

EFFECT OF DIETARY INCORPORATION OF THE SUGARCANE MOLASSES ON THE GROWTH PERFORMANCE, CARCASS AND ORGANOLEPTIC QUALITY OF JAPANESE QUAIL (*Coturnix japonica*) REARED IN IVORY COAST

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ABSTRACT
This study is carried out to assess the influence of molasses on growth, carcass yields and organoleptic quality of quail. To do this, 750 day old quails with an average weight of 8.21 ± 0.2g were divided into 5 batches of 150 quails. The five batches were fed rations which differed by their molasses content. This is supplementation with 0%; 2%; 4%; 6% and 8% of molasses. Then, the chemical characteristics of the staple feed and molasses, growth parameters, carcass yields and organoleptic quality of quail meat were determined. The results show that molasses is high in total sugar (65.8%) and low in protein (2.3%) and fat (0.09%). Also, the average live weight of quails fed with the 2% and 4% molasses rations are higher (231.5g and 229.7g). In addition, the feed index and quail performance index were better with rations containing 2% and 4% molasses. With the exception of the quail with the ration of 8% whose carcass and organ yield is low, no difference was revealed on the carcass yield and the proportion of quail organs ($p > 0.05$). As for organoleptic quality, the molasses content had no significant effect on the flavor and tenderness of the meat ($p > 0.05$). However, the juiciness scores of the meat of quails fed the 2% and 4% rations were higher than that of the other rations ($p < 0.05$). The effect of molasses would be more profitable for quail rearing, at lower levels.

Keywords: *Quail, Growth, Molasses, Organoleptic Quality, Carcass*

INTRODUCTION

Livestock is an important sector in food self-sufficiency. This is a promising sector given the growing demand for animal protein. According to the PSDEPA (2014), the popularization of short-cycle products such as quail can help improve food security in terms of animal proteins. Indeed, quail rearing gives good quality protein in record time (Siyadati *et al.*, 2011; Shalome & Uwadiae, 2021). However, the price of the feed is a constraint that must be removed because it represents nearly 60% of the production cost of quail (Shamna *et al.*, 2013). In response to this concern, research is being carried out to minimize the costs of quail feed. Thus, it is envisaged the incorporation of molasses in the feed formulas of quail. Indeed, molasses is a by-product of the processing of sugar cane (*Saccharum officinarum*). The annual production of sugar cane in Côte d'Ivoire is estimated at 170,000 tonnes (Yao, 2019). Molasses is the residue of cane juice obtained after it has been clarified and the sugar is extracted. Sugar cane molasses is essentially an energy feed. It contains sucrose, reducing sugars and other carbohydrate substances (Archimède *et al.*, 2011). The sugar in molasses, like most cellular carbohydrates, is processed by monogastric livestock. In addition, it is a factor in the palatability of feed (Archimède *et al.*, 2013). Molasses is used at levels of 3 to 5% in pelletized feeds as an agglomeration binder. In pigs, the dietary incorporation of molasses can reach up to 8% in the feed formula (INRA, 2002). Although these resources are available and less expensive, there is very little study on the incorporation of sugar cane molasses in animal feed. No study mentions its optimal level of use in quail rearing. Controlling its use could improve the production of Japanese quail. Thus, this study aims to assess the effect of molasses on growth performance, carcass characteristics and organoleptic parameters of meat.

MATERIALS AND METHODS

The study took place at the Labograin farm. Labograin is located in the town of Bingerville (Ivory Cost) in a dense forest area with a humid tropical climate with where there is a rainfall of 1653 mm.

Animals

The animals used consisted of 750 Japanese quails one day old with an average weight of 8.21 ± 0.2g. These quail are divided into 5 batches of 150 quails. The five batches each corresponded to a feed treatment. This is a control feed (0% molasses) and 4 other feeds supplemented with respectively 2%; 4%; 6% and 8% sugar cane molasses (*Saccharum officinarum*). Each batch was divided randomly into three batches of 50 quails.

Feeds

Feeds are presented in the floury form. They were produced by the poultry feed production unit of the company Labograin. The molasses used was obtained from the sugar cane production and processing company (SUCRIVOIRE). The said company is located in the north-west of the Ivory Coast, in the department of Borotou-Koro.

Experimental layout

For the different batches formed, five formulated rations were distributed to the quails. The five rations differ in the molasses content. Batch 1 is fed with the ration comprising 0% of molasses (control feed). Batch 2 is fed with the ration comprising 2% of molasses. Batch 3 is fed with the ration comprising 4% of molasses. Batch 4 is fed the ration comprising 6% of molasses. As for batch 5, it is fed with the ration comprising 8% of molasses. Each ration was distributed to the corresponding batch of birds according to the experimental batching arrangement.

Technical monitoring of quails

The animals were reared under the same conditions of temperature, density, lighting and hygiene. The breeding equipment was also identical for all the batches. The temperature in the chamber was maintained at 35 °C for 0-7 days, 32 °C for 8-21 days and 26-30 °C after 22 days of age. The animals were distributed so as to obtain a density of 100 quails/m^2 from 0-21 days and 50 quails/m^2 from 22 to 42 days. The applied light program is 24 hours from 0 to 6 weeks. Food and water were distributed ad libitum twice a day (8 a.m. and 5 p.m.).

Collection of data

The quails were weighed every week at the same time using a tescoma brand electronic scale, with a capacity of 3kg and a precision of 1g. Daily weighings of the feed distributed and feed refusals were also carried out. Daily mortality was recorded on a technical sheet. At 42 days of age, 12 males and 12 females per feed treatment (i.e. 3 males and 3 females per replication) were used to assess carcass and organ yield. The quails used have a body weight close to the group average. These quails were fasted for 3 hours. Then they were individually weighed and sacrificed. After bleeding, the legs were removed from the carcass by disarticulation of the tarsus and head. The carcasses are then plucked before being eviscerated. The organs (heart, liver, lung, abdominal fat) were dissected, removed and weighed separately. The empty carcasses (ready to cook) were also weighed. These different weighings were carried out using a tescoma brand electronic scale, with a capacity of 300g and a precision of 0.1g.

Chemical analysis of molasses and staple feed

The basic ration and molasses were analyzed at the Central Analysis Laboratory of NANGUI-ABROGOUA University and at the Abidjan Technical High School. At the Central Analysis Laboratory of NANGUI-ABROGOUA University, analyzes consisted in determining the content of dry matter, fat, crude fiber and protein according to the AOAC method (1990 and 1995). As for the determination of the mineral content, it was carried out at the Abidjan Technical High School Laboratory according to the method of Houk *et al.,* (1980) and Duche *et al.,* (1992). The total sugar content of the molasses was also determined according to the method of Dubois *et al.,* (1956). The dosage of reducing sugars and sucrose in molasses were determined respectively according to the methods of Bernfeld (1955) and Bertrand (1964).

Determination of the average live weight

It is determined according to the method of N'guessan *et al.,* (2018). The average bodyweight (PVm) of quail is the ratio between the sum of the individual weights of the same batch and the total. It is determined as follows:

$$\text{Average bodyweight} = \frac{\text{Sum of Weights}}{\text{Total number of individuals}}$$

Determination of average daily gain

It is determined according to the method of Hantanirina *et al.,* (2013). The weekly weight measurements made it possible to calculate the average daily gain (ADG) by making the ratio between the weight gain during a given period and the corresponding duration.

Determination of average feed consumption

The average feed consumption was determined by the method of Mabeki (2011). The daily weighing of the quantities of feed distributed and feed refusals made it possible to calculate the daily consumption of quails. The average feed consumption is determined as follows:

$$\text{Average feed consumption} = \frac{\text{Feed distributed} - \text{Feed refusals}}{\text{Number of individuals}}$$

Determination of the consumption index

The consumption index is determined according to the method of Hantanirina *et al.,* (2013). The consumption index results from the ratio between the amounts of feed ingested at a given period and the weight gain at the same period.

Determination of mortality rate and viability

The mortality rate and viability are determined according to the method of Mabeki (2011). The mortality rate is the ratio between the number of dead animals and the initial total number of animals multiplied by 100. As for viability, it is determined as follows:

Viability (%) = 100 - Mortality rate

Determination of the performance index

The performance index or production index (PI) is determined according to the method of Kaur & Mandal (2015). It is determined as follows:

$$\text{Performance index} = \frac{\text{Weight gain (g)}}{\text{Consumption index}}$$

Determination of carcass and organ yields

The different weights carried on the empty carcasses (Ready to Cook) and edible organs (liver, heart, gizzard, abdominal fat) were used to calculate carcass yields and proportions of the organs relative to body weight. These parameters are determined according to the method of Djitie *et al.,* (2015). They are determined as follows:

Weight of the carcass = [live weight - weight of the organs (head + legs + blood + feathers + viscera)].

$$\text{Carcass yield (\%)} = \frac{\text{Weight of the carcass (g)}}{\text{Live weight of the animal (g)}} \text{x}100$$

$$\text{Proportion of the organ (\%)} = \frac{\text{Weight of the organ (g)}}{\text{Live weight of the animal (g)}} \text{x}100$$

Evaluation of the organoleptic characteristics of quail meat

The evaluation of the organoleptic characteristics was carried out according to the combined and adapted methods of Touraille (1994), Micol *et al.,* (2010) and Salifou *et al.,* (2013). Thus, a panel is made up of 16 tasters including 8 women and 8 men. These tasters were chosen at random from the population and are between 25 and 50 years old. The animals used consist of 12 male quails per feed treatment (ie 4 quails per replication). After slaughter, different pieces were taken for different sensory analyzes. These pieces were drained and put in different pans identified according to the diet. Then they were cooked in water for 30 minutes. The cooking was done without seasoning and concomitantly at 100 °C. The samples were coded with 2-digit numbers and presented to the tasters. All samples are presented to the tasters at the same time in order to allow them to evaluate them a second time if necessary. The tests were carried out in a ventilated room protected from all odors as well as from auditory and visual distractions. The parameters chosen for the assessment of the organoleptic quality of the meat focused on flavor, juiciness and tenderness. Before the start of the test, the properties of the various parameters determined were explained to the tasters. The flavor corresponds to the olfactory and taste perceptions perceived during the tasting. Juiciness is defined by the more or less dryness of the meat during tasting. As for tenderness, it is defined as the ease with which a meat can be sliced and chewed. During the tasting, each taster had a scoring sheet established according to the model of Salifou *et al.,* (2013). This model is made up of a scale from 0 to 5. Each taster is instructed to mark with a cross his assessment of the organoleptic quality of the meat. For the flavor, the value 1 corresponds to a very weak intensity, 2 to weak, 3 to acceptable, 4 to strong and 5 to very strong. For juiciness, a value of 1 corresponds to very dry, 2 to dry, 3 to acceptable, 4 to soft and 5 to very soft. As for tenderness, the value 1 corresponds to very hard, 2 to hard, 3 to acceptable, 4 to tender and 5 to very tender. At the end, each taster should give an overall mark of appreciation ranging between 1 and 10.

Statistical analyzes of data

Descriptive statistics (determination of the mean, standard deviation and coefficients of variation) were used. The DUNCAN test was applied to compare the means at the 5% threshold using the STATISTICA7.1software.

RESULTS

Physicochemical composition of molasses and staple food

The physicochemical compositions of the sugarcane molasses and the staple feed are reported in Tables 1 and 2, respectively. It appears from Table 1 that the molasses has a high moisture content (27.1% of the crude product). Its total sugar and reducing sugar content is 65.8% and 16.2% respectively. It contains 9.7% mineral matter and 4.71% potassium. However, it is low in protein (2.3%) and fat (0.09%). It appears from this Table 2 that the staple feed is rich in energy and protein. It contains 3008.2Kcal / Kg of metabolizable energy and 25.69% protein.

Table 1: Physicochemical composition of sugar cane molasses

Parameters	Content (%)
Dry matter	72.9±1.0
Mineral matter	9.7±0.5
Crude protein	2.3±0.6
Fat	0.09±0.1
Total sugars	65.8±4.2
Reducing sugars	16.2±0.8
sucrose	35.7±1.5
Calcium	0.67±0.2
Chlorine	1.48±0.09
potassium	4.71±0.24
Magnesium	0.1±0.08
sodium	0.2±0.06
Phosphorus	0.13±0.05

Table 2: Physicochemical composition of the staple feed

Parameters	**Content**
Dry matter (%)	88.3±0.31
Metabolizable energy (kcal/kg)	3008.2±21.60
Total nitrogenous matter (%)	25.69±0.3
Energy/protein ratio	117.1
Fat (%)	3.97±0.15
Crude fiber (%)	4.3±0.63
Calcium (%)	1.19±0.52
Phosphorus (%)	0.65±0.00

Feed consumption of quails

The evolution of the daily consumption of quails is presented in Table 3.

In all batches, food consumption increased with the age of the quail. The feed consumption of quails fed with rations containing 2% and 4% molasses is higher than that of other quails. From 0 to 42 days, quail fed with 2% of molasses and the one fed with 4% consumed respectively a total of 770,6g and 781,5g of feed. Quails in the 8% molasses ration recorded the lowest feed consumption (713.8g).

Table 3: Feed consumption quail (g / quail / day)

Age of quails (week)	**0% molasses**	**2% molasses**	**4% molasses**	**6% molasses**	**8% molasses**
1	$5.91±0.09^{a}$	$6.03±0.08^{a}$	$5.96±0.05^{a}$	$5.85±0,05^{a}$	$5.66±0.1^{b}$
2	$13.5±0.05^{ab}$	$13.7±0.05^{a}$	$13.4±0.02^{b}$	$13.4±0.04^{b}$	$12.5±0.1^{c}$
3	$17.8±0.1^{b}$	$18.4±0.2^{a}$	$17.9±0.3^{b}$	$17.8±0.1^{b}$	$16.9±0.4^{c}$
4	$21.8±0,1^{b}$	$22,5±0,3^{a}$	$23±0,6^{a}$	$21,8±0,03^{b}$	$21,2±0,2^{c}$
5	$22,2±0.3^{d}$	$23.7±0.2^{b}$	$24.3±0.4^{a}$	$22.8±0.3^{c}$	$21.5±0.3^{e}$
6	$24.7±0.4^{c}$	$25.9±0.5^{b}$	$27.2±0.3^{a}$	$24.7±0.6^{c}$	$24.3±0.4^{c}$
Total	$741.0±4.9^{c}$	$770.6±3.8^{b}$	$781.5±4.2^{a}$	$743.9±5.8^{c}$	$713.8±3.3^{d}$

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

Average live weight

The weight evolution of the quails is presented in Table 4. From the first week to the fifth week of age, the quails with the 2% molasses ration have a higher average live weight than those of the other rations ($p<0, 05$). Compared to the quails from the control ration (0% molasses), those with the 4% molasses ration recorded a higher mean live weight at weeks 5 and 6 ($p <0.05$). In adulthood (6 weeks), the average live weight of quails fed with rations of 2% and 4% of molasses are significantly higher (231.5g and 229.7g respectively). Quails of 8% of molasses ration recorded the lowest average weight (181g).

Table 4: Evolution of the average live weight (g) of quails

Age of quails (week)	0% molasses	2% molasses	4% molasses	6% molasses	8% molasses
0	8.21±0.03[a]	8.2±0.03[a]	8.21±0.02[a]	8.18±0.03[a]	8.22±0.06[a]
1	31.1±0.2[b]	32.7±0.3[a]	30.0±0.19[c]	28.5±0.4[d]	26.2±0.4[e]
2	68.8±0.2[b]	71.3±0.2[a]	67.0±0.1[c]	64.8±0.3[d]	55.1±0.1[e]
3	106.3±0.5[b]	112.9±0.5[a]	104.2±0.9[c]	99.3±1[d]	85,9±0,8[e]
4	147,4±1,2[b]	156,1±1,8[a]	146±1,3[b]	137±0,8[c]	120.9±1.9[d]
5	182.5±1.7[c]	195.4±2.1[a]	188.4±1.4[b]	171.8±1[d]	153.5±2.9[e]
6	215.2±2.3[b]	231.5±2.1[a]	229.7±1.9[a]	199.6±2.6[c]	181.0±2.4[d]

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

Average daily gain

Table 5 shows the effect of dietary intake of molasses on the weekly change in mean daily gain of quails. From the first to the third week, the average daily gain of the quails with the 2% of molasses ration is significantly higher than those of the other batches ($p<0.05$). However, the average daily gain of the quail from the 4% of molasses ration was significantly higher than those from the other rations at weeks 5 and 6 ($p<0.05$). Overall, over the period of the trial (0 to 6 weeks), the average daily gain of quails fed with the 2% ration (5.28g / day) and the 4% ration (5.25g / day) is significantly higher ($p<0.05$). The ration containing 8% molasses recorded the lowest average daily gain (4.11 g / day).

Table 5: Weekly evolution of the average daily gain of quails (g / day)

Age of quails (week)	0% molasses	2% molasses	4% molasses	6% molasses	8% molasses
1	3.27±0.03[a]	3.29±0.05[a]	3.11±0.03[b]	2.9±0.05[c]	2.57±0.06[d]
2	5.39±0.02[c]	5.52±0.04[a]	5.28±0.01[b]	5.19±0.01[d]	4.14±0.06[e]
3	5.35±0.09[b]	5.94±0.1[a]	5.32±0.12[b]	4.92±0.1[c]	4.40±0.13[d]
4	5.88±0.11[a]	6.16±0.07[a]	5.98±0.2[a]	5.11±0.07[b]	4.7±0.05[c]
5	5.01±0.07[c]	5.62±0.2[b]	6.06±0.19[a]	4.97±0.11[d]	4.67±0.15[e]
6	4.67±0.12[c]	5.15±0.2[b]	5.74±0.25[a]	3.98±0.18[d]	3.93±0.2[e]
Average	4.93±0.05[b]	5.28±0.06[a]	5.25±0.04[a]	4.56±0.01[c]	4.11±0.03[d]

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

Consumption index of quails

Table 6 shows the effect of dietary intake of molasses on the consumption index (CI) of quails. Over the whole period of the test (0-42 days), the consumption index of quails fed with 2% of molasses and that of quails with 4% of molasses ration are significantly lower (respectively 3.38 and 3.4). Quails of 8% of molasses ration recorded the highest consumption index (4.02).

Table 6: Evolution of the consumption index of quails

Age of quails (week)	0% molasses	2% molasses	4% molasses	6% molasses	8% molasses
1	1.81±0.04[d]	1.83±0.02[d]	1.92±0.02[c]	2.02±0.03[b]	2.2±0.04[a]
2	2.5±0.01[c]	2.47±0.02[c]	2.53±0.01[bc]	2.58±0.01[b]	3.02±0.04[a]
3	3.33±0.05[c]	3.09±0.03[d]	3.36±0.04[c]	3.61±0.05[b]	3.85±0.06[a]
4	3.71±0.08[d]	3.64±0.05[d]	3.85±0.06[c]	4.04±0.05[b]	4.24±0.06[a]
5	4.43±0.06[ab]	4.22±0.16[bc]	4.01±0.08[c]	4.59±0.15[a]	4.61±0.2[a]
6	5.3±0.16[b]	5.02±0.05[b]	4.74±0.03[c]	6.22±0.2[a]	6.19±0.2[a]
Average	3.51±0.05[c]	3.38±0.04[d]	3.40±0.04[d]	3.84±0.02[b]	4.02±0.06[a]

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

Effect of molasses on mortality

The effect of feed intake of molasses on quail mortality is shown in Table 7. It can be seen from this table that the quail mortality rate for rations of 0%; 2% and 4% of molasses are not significantly different (p> 0.05). However, the inclusion of 6% and 8% of molasses in the ration negatively affected the health status of the quails (p<0.05). From 0 to 42 days, the lowest mortality (3.33%) was recorded with the rations of 0% and 2% of molasses. The ration of 8% of molasses recorded the highest mortality rate (12%).

Table 7: Effect of molasses on the mortality rate of quails (%)

Age of quails (days)	0% molasses	2% molasses	4% molasses	6% molasses	8% molasses
0-21	3.33±1.2[b]	3.33±2.3[b]	4.00±2.0[b]	7.33±1.2[a]	8.67±1.2[a]
22-42	0.00±0.0[b]	0.00±0.0[b]	0.00±0.0[b]	0.00±0.0[b]	3.33±1.4[a]
0-42	3.33±1.2[c]	3.33±2.3[c]	4.00±2.0[c]	7.33±1.2[b]	12.00±2.6[a]

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

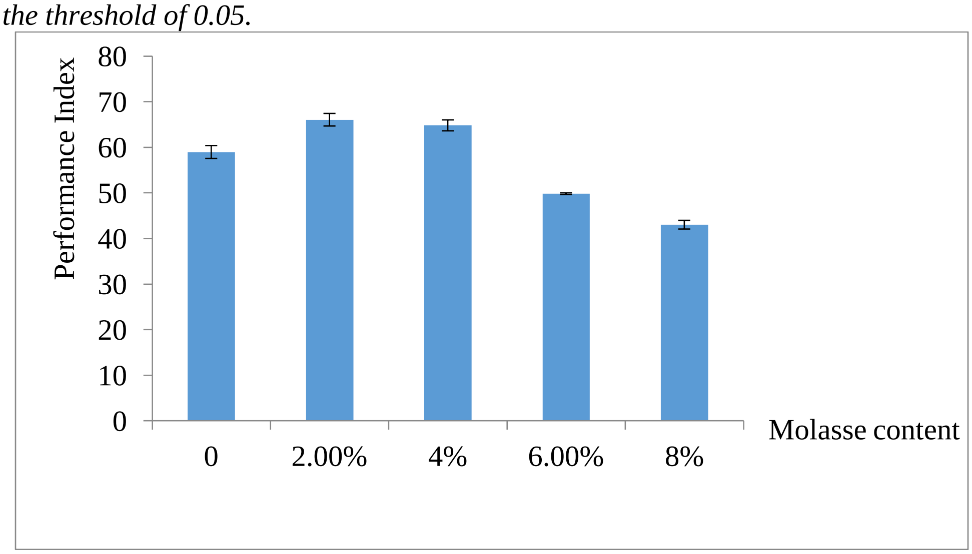

Figure 1: Effect of molasses on the performance index of quails

Effect of molasses on the performance index of quails

Figure 1 illustrates the effect of feed intake of molasses on the performance index of quails. It can be seen from this table that the feed intake of 2% and 4% of molasses positively influenced the performance index of quails. On average, the performance indices of quails fed with the 2% and 4% of molasses rations are significantly higher (66.1 and 64.8) than those of quails from other rations ($p<0.05$). Quails with the 8% of molasses ration recorded the lowest index (43.02).

Effect of molasses on carcass and organ yield

The carcass yield and proportions of the organs relative to body weight are shown in Table 8. Overall, the carcass yield varies between 66.7% and 69.5%. Except for the carcasses of the ration 8%, no significant differences were revealed between the performances of animal carcasses who consumed different feed rations ($p>0.05$). The ration containing 8% of molasses induced the lowest yield (66.7%) compared to other feed treatments. Regarding the proportions of the organs, the proportion of the gizzard is identical from one feed treatment to another ($P> 0.05$). However, the liver proportion of quails from the 6% and 8% of molasses ration is significantly higher than that of the other rations. The proportion of the heart (0.77%) of the quail of 8% of molasses ration is significantly higher than that of the other rations ($P<0.05$). As for the proportion of abdominal fat, it is higher with the quail of the 2% and 4% of molasses ($P<0.05$).

Table 8: Effect of molasses on carcass and organ yield of quails (%)

Carcass and organs	0% molasses	2% molasses	4% molasses	6% molasses	8% molasses
Carcass	68.9 ± 1.20^{a}	69.5 ± 1.10^{a}	69.2 ± 0.09^{a}	67.8 ± 1.00^{ab}	66.7 ± 1.10^{b}
Liver	1.69 ± 0.01^{b}	1.72 ± 0.01^{b}	1.7 ± 0.03^{b}	1.77 ± 0.01^{a}	1.82 ± 0.02^{a}
Heart	0.70 ± 0.01^{b}	0.69 ± 0.02^{b}	0.72 ± 0.01^{b}	0.71 ± 0.02^{b}	0.77 ± 0.02^{a}
Gizzard	1.80 ± 0.06^{a}	1.82 ± 0.10^{a}	1.81 ± 0.15^{a}	1.78 ± 0.11^{a}	1.81 ± 0.07^{a}
Abdominal fat	0.56 ± 0.02^{b}	0.65 ± 0.02^{a}	0.64 ± 0.03^{a}	0.42 ± 0.03^{c}	0.38 ± 0.05^{c}

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

Organoleptic characteristics of quail meat

Table 9 shows the effect of dietary incorporation of molasses on the organoleptic characteristics of quail meat. It emerges from this table that the dietary incorporation of molasses did not have a significant effect on the flavor and tenderness of the meat ($p> 0.05$). However, dietary incorporation of 2% and 4% of molasses are significantly improved the juiciness of quail meat ($p<0.05$). The tasters assigned the best juiciness scores (3.88 and 3.84) to the quail meats of 4% and 2% of molasses. The 8% of molasses ration had the lowest juiciness score. As for the overall assessment of quail meat, no statistical difference was revealed between the meats of the different feed treatments ($p> 0.05$).

Table 9: Organoleptic characteristics of quail meat

Parameters	0% molasses	2% molasses	4% molasses	6% molasses	8% molasses
Flavor	3.44 ± 0.50^{a}	3.56 ± 0.52^{a}	3.5 ± 0.51^{a}	3.31 ± 0.49^{a}	3.38 ± 0.5^{a}
Juiciness	3.06 ± 0.25^{b}	3.84 ± 0.34^{a}	3.88 ± 0.30^{a}	3.00 ± 0.30^{b}	2.81 ± 0.40^{b}
Tenderness	3.13 ± 0.50^{a}	3.00 ± 0.70^{a}	3.06 ± 0.44^{a}	2.94 ± 0.57^{a}	2.88 ± 0.34^{a}
overall assessment rating	6.94 ± 0.90^{a}	7.50 ± 0.89^{a}	7.19 ± 1.05^{a}	6.88 ± 0.81^{a}	6.63 ± 0.96^{a}

The same letter (a, b, c, d or e) on the same line means that there is no significant difference between the batches, at the threshold of 0.05.

DISCUSSION

The molasses used in this test is a wet product rich in sugar. However, it is low in fat and protein. These results were confirmed by Archimedes *et al.,* (2011) and Tendonkeng *et al.,* (2019). According to these authors, molasses contains about 25% of water, 30% of sucrose, 25% of reducing sugars and other carbohydrate substances. Other authors have indicated that the physicochemical composition of molasses is very variable. The different types of molasses are linked to the manufacturing process. They differ in their chemical composition in relation to the gradual extraction of sugar. The common characteristic of molasses is their high sugar content and low protein content (Archimède *et al.,* 2011). According to Christon & Le Dividich (1978), the protein content of molasses can reach 10.2%. This variation in the protein content of molasses is due to the cultivation conditions applied to the cane and in particular to the importance of nitrogen fertilization and the soil's richness in organic matter. The results of the present study show that molasses is rich in minerals more precisely, in potassium. This high mineral content is believed to be due to the technological process for processing sugar cane. Indeed, according to Archimedes *et al.,* (2011), technological processes for transforming molasses increase the concentration of industrial impurities (non-digestible organic matter) and minerals.

In this study, the feed consumption of quail with 2% and 4% molasses rations was significantly higher. Dietary intake of 2% and 4% molasses would have a positive effect on palatability in quail. The low consumption observed with the 6% and 8% molasses rations would be linked to the problems of feed homogeneity, making them less appetizing. Indeed, at high content, the viscous consistency of molasses poses problems of texture and homogeneity of the complete ration (Archimède *et al.,* 2011). The average live weights of quails fed the 2% and 4% of molasses rations are significantly higher than other quails. The average live weights obtained at 6 weeks with the quail in the 2% and 4% of molasses rations are close to that obtained by Nikpiran *et al.,* (2013) with a diet supplemented with lactic acid bacteria (Saccharomyces Cerevisiae). These authors noted a live weight of 232g.

The Average daily gain of quails of the 2% and 4% Molasses Rations is significantly higher than that of the other rations. This improvement of the average daily gain could be explained by the increase of feed consumption for these batches. The results obtained in this study on weight gain were observed on ruminants by Preston (1995). According to this author, molasses-based rations can achieve growth rates greater than 1000 g / day for bullfighting cattle. In Japanese quail, average daily earnings between 4.89 and 5.89g / day from 1 to 28 days of age were recorded with diets containing 3% molasses by Abbas *et al.,* (2016). According to Archimedes *et al.,* (2013), for poultry, the maximum limit of the ideal dietary intake rate of molasses is set at 10%. Beyond this rate, there is a decline in growth performance.

In terms of the consumption index, the quails fed with the 2% and 4% molasses rations presented the lowest consumption indices. In fact, the consumption index is best when it is as low as possible. These low consumtion indices could be due to the effect of molasses on feed. Indeed, the use of molasses reduces the fine particles of the feed (Archimedes *et al.,* 2013). According to Kenny & Rollins (2007), when the concentration of fine particles of feed is high, the performance is poorer. These high concentrations result in low weight gains and high consumption indices. To maximize performance, the level of fine particles must therefore be minimized. The high consumption indices observed with rations containing 6% and 8% of molasses is due to improper use of the nutrients contained in these rations. According to Archimedes *et al.,* (2011), at high content, molasses would have a depressive effect on the use of proteins due to an increased loss of faecal nitrogen of endogenous origin. In addition, these authors recommend an increase in the protein level of diets that contain sugar cane molasses.

In this study, the quail mortality rates from the 2% and 4% molasses rations were 3.33% and 4%, respectively. According to Songhai (2011), the acceptable mortality rate in quail farming is 5% over the production cycle. This compliance with the standards could be due to a good sanitary condition of the quail rations of 2% and 4% molasses. In quails of 6% and 8% of molasses rations, the mortality rate is greater than 5%. This high rate could be due to digestive disorders caused by molasses. Indeed, high incorporation rates of molasses in the poultry feed ration lead to digestive disorders which result in diarrhea (Archimède *et al.,* 2011).

The performance index is a synthetic variable which makes it possible to make an overall assessment of the technical and economic performance of poultry farms. In this study, the performance index of quails fed the 2% and 4% molasses ration were significantly higher (66.1 and 64.8) than those of other quails. The quail performance indices for these two rations are also higher than that recorded by Kaur & Mandal (2015). Indeed, these authors found a performance index between 45.5 and 60.82 from 1 to 5 weeks of age. The increase in the performance index with the 2% and 4% molasses rations reflects better use of the molasses contained in this ration. Thus, the feed incorporation of 2% or 4% molasses makes it possible to optimize the economic profitability in quail.

The carcass yields obtained in this test vary between 66.7% and 69.5%. These returns are comparable to those recorded by Jahanian & Edriss (2015). However higher yield levels (73.95 to 78.03%), have been reported by Aygun *et al.,* (2011); Khaksar *et al.,* (2012); Guluma *et al.,* (2014) and Djitie *et al.,* (2015). According to Djitie *et al.,* (2015), this variation in quail carcass yield would depend on genetic types and slaughter age. The results of the present study also show that with the exception of carcasses of animals of the 8% of molasses ration, no significant difference was found between the performances of carcasses of animals that consumed the other feed rations. The carcass yield, which is lower for the quails of the 8% molasses ration, is thought to be due to their lower live weight. According to Siyadati *et al.,* (2011); higher carcass yields are obtained with higher live weight quails. In addition, the increase of molasses in the ration is most often accompanied by a decrease of carcass yield. The reduction of carcass yield results from the reduction in fat mass and a significant increase of visceral weight (Babatunde *et al.,* 1975). The proportion of liver and heart of quails in the ration containing 8% of molasses are significantly higher than those of other rations. These results are confirmed by Babatunde *et al.,* (1975). According to these authors, from an anatomical point of view, the high proportions of molasses lead to an increase in the weight of the liver, heart and kidneys of animals. The fact that the proportions of the liver and the heart of the ration containing 8% molasses were higher than those of the other treatments could reflect a hyper activity of these organs compared to those of the other treatments. According to Djitie *et al.,* (2015), the liver is an essential and priority organ in the body's detoxification process. He intervenes by working more intensely. This hyper activity is believed to be the cause of his hypertrophy. Similar results were observed by Djitie *et al.,* (2015) with a diet containing 27% of protein during the finishing period. The higher proportion of abdominal fat obtained with the 2% and 4% of molasses rations is linked to the higher feed consumption and bodyweight of the quail. These results have been confirmed by Jahanian & Edriss (2015).

Regarding sensory analysis, tasters were drawn to the juiciness of meats from quails fed with 2% and 4% of molasses. The higher juiciness notes could be explained by the higher food consumption of these quails. According to Lebret *et al.,* (1999); in most species, the reduction of dietary level is accompanied by a reduction in carcass and muscle adiposity. In pigs, a restriction in finishing period reduces the intramuscular lipid levels, and could alter the tenderness and juiciness of the meat. In this study, the tenderness of quail meat was identical from one food treatment to another. According to Chriki *et al.,* (2013); when a muscle is rich in collagen, its meat is less tender. Tenderness is also influenced by the ripening of the meat (Ouali *et al.,* 2006). In pigs, the ingestion of feed rich in molasses does not influence meat tenderness. Indeed, the distribution of feed containing molasses for the purpose of increasing the glycogen reserves of the muscle and the liver does not improve the maturation of the meat (Christon & Le Dividich, 1978). The results of this study show that the dietary intake of molasses does not influence the flavor of quail meat. According to Lebret *et al.,* (2015), the smell and taste of meat is altered with the dietary incorporation of vegetable oils.

CONCLUSION

This study evaluated the effect of dietary intake of molasses on growth, carcass yields and organoleptic quality of quail. It appears from the study that dietary incorporation of 2% of molasses improves average daily gain of the quail from 1 to 4 weeks of age. On the other hand, the quails whose ration contained 4% of molasses, recorded at weeks 5 and 6, the highest average daily gain. The consumption index and quail performance index were improved with rations containing 2% and 4% of molasses. Regarding carcass and organ yields, no significant difference was found between the quails of the different rations except for the quail of the 8% molasses ration which showed low yields. Regarding organoleptic characteristics, rations containing 2% and 4% molasses improved the juiciness of the quail meat. Although molasses is high in sugar, its incorporation into quail feed should be done in low doses in order to improve quail performance.

Disclosure of conflict of interest

All authors have read, understand and agreed to the submission guidelines, policies and submission declaration of the journal. All authors have approved the manuscript as submitted.

Statement of ethical approval

The study was approved by the Institutional Animal Ethics Committee of University Nangui Abrogoua of Ivory Coast

ACKNOWLEDGMENTS

We would like to thank the company Labograin Africa for facilitating the quails rearing. We also thank University of Nangui Abrogoua and Abidjan Technical High School for the chemical analysis.

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