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EFFECTS OF REPLACING CORN WITH CULL DATES AND RUMEN CONTENT EXTRACT ON PRODUCTION PERFORMANCES AND THE CHARACTERISTICS OF BROILER CHICKEN CARCASSES

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ABSTRACT

The aim of this study was to determine the effect on the production performances and carcass characteristics of local broiler chickens of replacing corn with cull dates from agro-food industries in oasis zones and of complementing this with rumen content extract from sheep abattoirs in the chickens’ feed rations. A total of 200 male and female day-old chicks of local stock, with an average weight of 25±2 g, were divided randomly into 4 groups of 50 individuals, each group distinguished by the respective rate of substitution of corn by cull dates (0 %, 20 %, 30 % and 40 %) for a period of 48 days. Each group was divided into ten (10) packages of 05 subjects. The live weights after 48 days improved for all experimental groups, recording an increase of + 162 g (20 %) ; + 82 g (30 %) and + 31 g (40 %). All of the characteristics remained unchanged for all groups with the exception of liver weight, which was lower in the experimental groups. Substituting 40% of the corn by culls dates while adding 250 ml rumen content extract per kilogramme of broiler chicken feed increased the live weight and average daily gain.

Keywords: broiler chicken, consumption index, cull dates, rumen content extract, weight gain.

INTRODUCTION

Poultry farms provide white meat more quickly than those supplying red meat. They provide the most disadvantaged people with cheaper animal proteins than those derived from red meat. Nevertheless, in most emerging countries, livestock production is dependent on imports of raw materials used in the preparation of feed for these monogastric animals, as is the case in Algeria. In this type of production, food accounts for 60% to 70% of farming expenditure (Belhouadjeb and Chehat 2013) and to ensure a reduced impact on the kilogram of meat produced, it makes sense to reduce the cost of feed formulae by using unconventional foodstuffs and in particular agro-industrial by-products such as cull dates from oasis regions. Taken from the date packaging and processing industries, they are available in large quantities (Chehma *and al* 2000) and their chemical composition and nutritional value have been determined (Arbouche 2012, Arbouche *and al* 2018). Several studies have focused on the incorporation of the by-products of dates (Meradi *and al* 2016, Meradi and Alloui 2009) and the improvements made to them through chemical treatment (Chehma *and al* 2009, Chehma and Longo 2004, Arbouche and Arbouche 2008, Arbouche 2012). A number of production performance improvement tests were examined, which used growth enhancers (Rahman *and al* 2012), probiotics, with or without minerals, and vitamins (Anjum *and al* 2005, Islam *and al* 2004, Harun-Ar-Rashid *and al* 2015), exogenous enzymes, essential amino acids (Fernandes *and al* 2015, Murakami *and al* 2012) and rumen juice Zebrowska *and al* 1989). Rumen juice was tested in monogastric animals, and in particular broiler chickens, as a growth enhancer (Kuçukersan *and al* 2002).

The aim of our study is to determine the influence of replacing corn with cull dates and injecting 250 ml rumen content extract per kilogram of food into the different substitution plans with a view to offsetting the impact of the protein deficit of cull dates on the zoo-technical performances and the quality of broiler chicken carcasses.

MATERIALS AND METHODS

Animals, diet and experimental protocol

The test was conducted at the El Kala poultry facility (El-Tarf wilaya) in a closed, statically ventilated building reserved for experiments on broiler chickens. A total of 200 male and female day-old chicks of local stock, with an average weight of 25±2 g, were divided randomly into 4 groups of 50 individuals allocated a surface area of 5 m^2 per group with litter made from crushed durum wheat straw. Each batch was divided into ten (10) packages of 05 subjects, banded and numbered.

The cull dates (CD) of Deglet Nour variety were provided by packaging plants in south-eastern Algeria (Biskra). They were first dried in the sun then crushed using a hammer mill with a 1-mm grate. The chemical composition is presented in table 1.

Table 1. Chemical composition of cull dates (Arbouche *et al.,* 2018)

Organic matter (% of DM)	97.1
Total nitrogenous matter (% of DM)	4.2
Crude fibre (% of DM)	9.4
Fat (% of DM)	8.2
Mineral matter (% of DM)	2.9
Total sugars (% of DM)	62.3
Nitrogen-free extract (% of DM)	66.1

Crude energy (kcal/kg of DM)	4,235
Metabolisable energy (kcal/kg of DM)*	3,683
Lysine (g/100g of proteins)	3.2
Methionine (g/100g of proteins)	1.5
Cystine (g/100g of proteins)	1.7

DM: dry matter

*Metabolisable energy: estimated using the formula developed by Carpenter and Clegg (1956) with ME (kcal/kg of DM) = 35.3 x CP (%) + 79,5 x EE (%) + 40.6 x NFE (%) + 199

(EM: metabolisable energy, PB: crude protein, EE: ether extract, NFE: nitrogen-free extract), from Carpenter and Clegg (1956)

The rumen content was recovered from abattoirs immediately after the sheep were eviscerated. It was treated with a 1% solution of hydrochloric acid, in order to prevent flies from laying any eggs, then spread on plastic film. During the sun-drying process, the dates were turned several times. The rumen content (RC) was soaked in water heated to 80°C at a rate of one kilogramme per litre (1 kg / l) and mixed every six hours for 24 hours. After filtering, the extract (RCE) was refrigerated at a temperature of 4°C (Blancou 1976). The total nitrogenous matter (TNM) and amino acid (AA) content is presented in table 2.

Table 2. Content of TNM (% of DM) and AA (as % of TNM) in ovine rumen content extract (RCEo)

RCE_o	TNM	Amino acid content								
		Cystine	Methionine	Threonine	Lysine	Glutamic acid	Aspartic acid	Arginine	Leucine	Isoleucine
	8.32	0.89	1.10	2.14	2.56	10.21	6.24	2.85	4.36	1.81

Using the WUFFDA software for the broiler chicken feed formulae, four iso-protein rations were prepared with 0 % (control feed), 20 %; 30 % and 40 % rate of substitution of corn by cull dates and 250 ml rumen content extract for the different breeding phases (table 3).

Table 3. Formulae (kg/100 kg of feed) for launch feed (1 to 20 days), growth feed (21 to 33 days) and final feed (34 to 48 days) distributed to the chickens according to the substitution rate of corn by cull dates soaked in rumen juice

Type of food	Launch				Growth				Final			
Rate of substitution	0	20	30	40	0	20	30	40	0	20	30	40
Ingredients												
Corn	61	48.8	42.7	36.6	64	51.2	44.8	38.4	70	56	49	42
Cull dates	0	12.2	18.3	24.4	0	12.8	19.2	25.6	0	14	21	28
Soya cake	30	30	30	30	27	27	27	27	21	21	21	21
by-products of milling	6	6	6	6	6	6	6	6	6	6	6	6
Bi-calcium phosphate	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
MVS	1.25	1.25	1.25	1.5	1	1	1	1	1	1	1	1
L-Lysine	0 .15	0 .15	0 .15	0 .15	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DL-Methionine	0.4	0.4	0.4	0.15	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Rumen content extract (ml)	0	250	250	250	0	250	250	250	0	250	250	250
Nutrient content as % of DM												

Metabolisable energy Kcal/Kg)	2,890	2,912	2,923	3,119	2,840	2,920	3,015	3,242	2,990	3,351	3,610	3,873
Crude protein (%)	21	22.18	22.02	21.51	20.33	21.21	21.02	20.85	18	19.8	19.1	18.75
Fat (%)	2.8	2.33	3.3	1.87	2.88	2.4	2.15	1.91	3.05	2.52	2.25	1.99
Mineral matter (%)	3	3	3.2	3.3	2.7	2.7	2.8	3	2.9	3	3	3.1
Crude fibre (%)	2.96	2.69	2.62	2.43	2.91	2.63	2.49	2.51	2.81	2.5	2.35	2.19
Lysine (%)	1.20	1.17	1.15	1.14	1.38	1.35	1.33	1.31	1.22	1.18	1.16	1.14
Methionine (%)	0.72	0.69	0.68	0.67	0.6	0.58	0.57	0.56	0.57	0.55	0.54	0.52

MVS (mineral-vitamin supplement) composed of: calcium: 16.8%, magnesium: 0.1%, sodium: 12.8%, chlorine: 20.5%, vitamin A: 750,000 IU, vitamin D3: 160,000 IU, vitamin E: 1,280 mg/kg, B1: 100 mg/kg, B2: 300 mg/kg, calcium pantothenate: 570 mg/kg, niacin: 1,750 mg/kg, B6: 99 mg/kg, K3: 190 mg/kg, folic acid: 35 mg/kg, biotin: 1 mg/kg, choline chloride: 25,000 mg/kg, iron carbonate: 2,500 mg/kg, copper (sulphate): 970 mg/kg, zinc (sulphate): 6,080 mg/kg, manganese (oxide): 7,500 mg/kg, iodine (iodate): 120 mg/kg, selenium (selenite): 25 mg/kg and other additives; DL-methionine: 180 g/kg, antioxidant, citric acid, orthophosphoric acid.

A temperature varying between 36 and 38°C was maintained over the first ten days thanks to gas incubators and lighting operated 24 hours a day before being reduced to 18 hours a day with 6 hours of night. The water and feed were distributed ad libitum. The chickens were vaccinated against Newcastle disease and infectious bronchitis on the 7th and 21st breeding day as well as against Gumboro disease at 14 days of age (no booster required). Furthermore, an anti-coccidian was administered in the drinking water at 17 and 34 days of age for two consecutive days.

The animals were weighed individually at 10, 20, 33, 42 and 48 days of age. During the breeding cycle, the feed was distributed freely after having been sprayed with 250 ml rumen content extract per kg of feed, and uneaten feed was weighed every day. The mortality rate was recorded every day throughout the entire duration of the experiment.

On the 49th day, 25 chickens picked at random from each group were killed. The live weight, eviscerated carcass weight and weight of the feet, head, feathers, gizzard, guts and liver were determined.

Statistical analysis

The descriptive statistic and the single-factor variance analysis (ANOVA) were conducted using the SPSS software (version 21, 2012) to analyse the live weight (LW), the average daily gain (ADG), the quantity of food ingested and the conversion index (CI). Using the post-hoc test by applying the Dunnett bilateral test made it possible to estimate the significance or homogeneity between the different sub-groups (comparison test between averages). The differences are deemed to be significant with an error risk of 5 %.

Economic analysis

The choice of the complete cost method was necessary to analyze the composition of the costs incurred in obtaining by-products. The main aim of this method is to calculate the most complete production costs possible, taking account of all expenses incurred during the production and processing of a finished by-product intended for poultry feed. This production cost does not include marketing costs, abnormal costs or storage costs not linked directly to production.

RESULTS

Throughout the entire duration of the experiment, we recorded no deaths. The weights at 10 days of age were significantly identical ($p<0.05$) for the groups with 0% (control), 20 % and 30 % corn substitution by cull dates, while the 40 % group displayed the lowest weight (176 g) (Table 4).

Table 4. Change in weight increase during the launch, growth and final phases according to the rate of substitution

	0	20	30	40	ESM	p
Launch phase						
Initial weight (g)	25	25	25	25		
Weight at 10 d (g)	185[a]	180[a]	182[a]	176[b]	2.60	0.03
ADG_{1-10} (g/d/animal)	16[a]	15[b]	16[a]	15[b]	0.28	0.03
Weight at 20 d (g)	552[a]	525[b]	556[a]	552[a]	8.15	0.04
ADG_{11-20} (g/d/animal)	37[a]	34[b]	37[a]	38[a]	0.80	0.02
ADG_{1-20} (g/d/animal)	26	25	27	26	0.42	0.566
Growth phase						
Weight at 33 d (g)	1,480[a]	1,520[b]	1,537[b]	1,542[b]	19.83	0.03
ADG_{21-33} (g/d/animal)	71[a]	76[b]	75[b]	76[b]	1.48	0.04
Final phase						
Weight at 48 d (g)	2,607[a]	2,769[b]	2,689[ab]	2,638[ab]	23.62	0.02
ADG_{34-48} (g/d/animal)	75[b]	83[a]	77[b]	73[b]	1.95	0.001
ADG_{1-48} (g/d/animal)	55	58	57	56	0.50	0.500

ADG: average daily gain (the indices show the period in days over which this parameter was calculated. The presence of different letters on the same line indicates a significant difference between diets ($P < 0.05$).

This group was characterized by an average daily gain (ADG) of 15 g, the same value as that recorded for the 20% group. The 0 % and 30% groups had identical ADGs (16 g). After 20 days, the trend appeared to reverse, with a significantly similar weight for the groups with 0 %, 30 % and 40 % incorporation of cull dates whereas the 20% group displayed a fall in weight (525 g) reflected by a low ADG (34 g) compared to the other groups, in which the ADGs were significantly comparable. Between the 1st and 20th day, the ADG was nevertheless similar for all groups ($p > 0.05$). With a weight of 1,480 g at 33 days of age, during the growth phase, the control group was the least representative group compared to the other groups, all of which displayed significantly greater weights proportional to the rates of cull date incorporation. The same observation could be made with regard to the ADGs over this period. During the final phase, the rate of substitution of corn by cull dates generated significantly greater weights for the experimental groups in relation to the control group ($p < 0.05$), the 20 % group being the heaviest with an ADG of 83 g, significantly higher than that of the other groups. The ADG across the entire breeding period (day 1 to 48) was significantly identical for all groups. The quantity of food ingested was significantly similar for the 0 % (control), 20 % and 40% groups across the entire process, with the 30 % group consuming a larger quantity (6,495 g) (Table 5).

Table 5. Change in quantity of food ingested and the consumption index according to the rate of substitution

	0	20	30	40	ESM	p
Food ingested (g)						
From 1 to 10 days	162[a]	159[b]	164[a]	146[c]	1.52	0.01
From 11 to 20 days	766[a]	779[b]	802[c]	731[d]	6.82	0.001
From 21 to 33 days	1,850[a]	1,811[a]	1,830[a]	1,928[b]	10.24	0.03
From 34 to 48 days	3,497[a]	3,468[a]	3,699[b]	3,433[a]	19.56	0.01
From 1 to 48 days	6,275[a]	6,217[a]	6,495[b]	6,238[a]	53.8	0.02
Consumption index (g/g)						
From 1 to 10 days	1.01[a]	1.02[a]	1.04[a]	0.96[b]	0.035	0.04
From 11 to 20 days	2.08[a]	2.26[b]	2.14[c]	1.94[d]	0.566	0.007
From 21 to 33 days	1.99[a]	1.81[b]	1.86[b]	1.94[a]	0.992	0.03
From 34 to 48 days	3.09[a]	2.7[b]	3.21[c]	3.13[c]	0.127	0.04
From 1 to 48 days	2.41[a]	2.24[b]	2.41[a]	2.36[ab]	0.32	0.01

The presence of different letters on the same line indicates a significant difference between diets ($P < 0.05$).

The consumption index for the 0 % and 30% groups remained the same while the 20 % group displayed the lowest CI at 2.26; the 40 % group recorded an intermediate value of 2.38.
During the launch phase, the quantity of food ingested displayed a saw-tooth pattern in relation to the rates of cull date incorporation in the chickens' diet, with the 40 % group recording a significantly lower quantity ingested (731 g). The same observation applied to the consumption index (CI). During the growth phase, the 0 %, 20 % and 30% groups were characterized by an identical quantity of food ingested, which was nevertheless below that of the 40% group (1,928 g), although the CI for the 0 % group remained similar to that of the 40% group. During the final phase, the 30% group maintained the highest level (3,699g) and the 0 %, 20 % and 30 % groups recorded significantly similar quantities ingested.
The slaughter parameters remain similar regardless of the rate of cull date incorporation in the chickens' diet, with the exception of the live weight, which remained lower (< 50 g) in the experimental groups and significantly different from that of the control group (65 g) (Table 6).

Table 6. Change in slaughter parameters according to the rate of substitution

	0	20	30	40	ESM	p
Parameters						
Live weight (g)	2,793	2,836	2,921	2,761	93.9	0.631
Weight evisc. carcass (g)	1,979	2,077	2,130	1,974	80.17	0.522
Weight of feet (g)	105	105	107	108	5.54	0.989
Weight of head (g)	70	63	72	74	4.91	0.402
Weight of feathers (g)	112	99	100	100	10.1	0.608
Weight of gizzard (g)	64	72	77	70	3.92	0.093
Weight of guts (g)	431	386	408	401	17.51	0.299
Weight of liver (g)	65.0[a]	46.2[b]	50.8[b]	48.2[b]	3.30	0.00

The presence of different letters on the same line indicates a significant difference between diets ($p < 0.05$).

Economic aspect

Our calculations concerning the price of feed distributed in each breeding phase are based on the average price of corn, currently at DZD 27/kg. For the processed rumen content (RC), the complete cost was DZD 12.514/kg (covering the labor costs for recovering the rumen and treating it with HCl, including the cost of the acid).

The experimental ration modified by the rumen content was processed when the ration was served. The weight of the liquid used is not considered as part of the weight of this feed. However, this treatment was proportional to the weight of the ration, i.e. quarter of a liter per kilo of feed, thereby allowing the additional cost of the treatment to be evaluated at DZD 261.98 per kilo of feed, with the exception of the control group (third line of table 7).

Table 7. Costs of different concentrates according to the rate of substitution.

Launch feed	0%	20%	30%	40%
Cost of corn + CD (DZD/Qx)	1,647	1,470.9	1,382.9	1,294.9
Cost of full concentrate (DZD/Qx) *	5,168	4,991.95	4,903.93	4,815.9
Cost of rumen content	0	261.98	261.98	261.98
Total cost of concentrate	5,168	5,273.93	5,165.91	5,077.88
Growth feed				
Cost of corn + CD (DZD/Qx)	1,728	1,543.29	1,450.94	1,358.59
Cost of full concentrate (DZD/Qx) *	4,925	4,740.29	4,647.94	4,555.59
Cost of treatment by Hcl_{1n}	0	261.98	261.98	261.98
Total cost of concentrate	4,925	5,002.27	4,909.92	4,817.57
Final feed				
Cost of corn + CD (DZD/Qx)	1,890	1,687.98	1,586.97	1,485.96
Cost of full concentrate (DZD/q) *	4,704	4,501.98	4,400.97	4 299.96
Cost of treatment by Hcl_{1n}	0	261.98	261.98	261.98
Total cost of concentrate	4,704	4,763.96	4,662.95	4,561.94

* Cost of full concentrate = cost of control concentrate – cost of quantity of corn removed + cost of quantity of cull dates added = cost of control concentrate – quantity substituted × difference in price between the two materials (corn and cull date). CD: cull dates

The cost of the cull dates (CD), including labor and amortization of the equipment used to recover and crush the dates, was evaluated at DZD 12.572/kg.

The prices of the concentrates of the control groups (launch = DZD 51.68/kg, growth = DZD 49.25/kg, final DZD 47.04/kg) are those provided by the national office for livestock feed (ONAB, 2018). The prices of the experimental concentrates were calculated according to the prices of the raw materials, constituents and substitution ingredients (Table 3 and Table 7).

The cost of production for the modified part of the ration (CPrs) (corn replaced by cull dates after substitution) was:

CPrs = Prd Xrd Xm+ Pm (Xm– Xrd Xm), where:

Pm: price of corn

Prd: prix of replacement factor (cull dates);

Xm: the quantity of concentrate used (corn) expressed as % for a calculation per unit; Xrd: the quantity of CD used to replace a proportion of corn expressed as % for a calculation per unit;

The feed cost (FC**)** is defined by the following formula:

FC / phase (in DZD) = quantity of feed consumed per animal × unit price of this feed

The feed cost to produce 1 kg of meat varies from DZD 116.44 (€ 0.862) for the control group to DZD 111.15 (€ 0.823), DZD 117.31 (€ 0.868) and DZD 112.63 (€ 0.834) for the 20%, 30% and 40% groups respectively.

Referring to the results obtained by Kaci (2014), who states that feed accounted for 60% of the total production cost, we hypothesize that all other costs are proportional to feed, which is the same as saying that there are no fixed costs or economies of scale. The estimated total production costs for our different groups are presented in table 8. This shows that the lowest production costs are those for the experimental groups (20%: € 1.37 € (DZD 185.25) and 40%: € 1.39 (DZD 187.71)), compared to the control group with € 1.437 (DZD 194.07).

DISCUSSION

Through this study, it is interesting to note that while the initial weight was low (25 g), explained by the use of a hardy, local breed that is widespread within the region (Mahammi *and al* 2014), the weight at 10 days of age and the ADG (16 g) remain comparable to those of the Isa Vedette breed and that partial substitution of corn by cull dates of up to 40 % generates a positive effect on live weight and ADG, the best results provided by a substitution rate of 20 % (2,769 g) while the 40 % group (2,638 g) also displayed a higher weight than the control group (2,607 g), i.e. +6% and +1.2% respectively. These results were obtained with the addition of 250 ml of rumen content extract (RCE) per kg of feed.

In the case of broiler chickens, several authors have reported the regressive effect of a cull date incorporation rate in feed greater than 20%, causing a reduction in both live weight and ADG (Meradi, *and al* 2016, Chehma *and al* 2009, Masoudi *and al* 2011). The addition of the probiotic (rumen content extract) promoted an increase in live weight and average daily gain up to an incorporation rate of 40%, as reported by Kuçukersan *and al* (2002). Generally speaking, the different incorporation rates of cull dates in animals' diets (0 to 40%) do not cause any variation in the quantity of food ingested (Masoudi and al, 2011), although they do result in a significant reduction in the consumption index of the 40% group in relation to the control group, an observation which is inconsistent with that of these same authors and El-Deek *and al* **(2010)**. The variations in carcass characteristics are not significant, as observed by Al-Homeidan (2003), although Al-Bowait and Al Sultan (2006) and Masoudi *and al* (2011) indicate a decline in these parameters as the incorporation rates of cull dates in feed increases.

The experimental diets have a positive influence on feed by improving growth performances (final live weight) (Table 8).

Table 8. Economic indicators according to the rate of substitution

	0			20			30			40		
Breeding period	UP	QI	PQFI	UP	QI	PQFI	UP	QI	PQFI	UP	QI	PQFI
1-20 d	51.68	928	47.95	53.04	938	49.75	52.16	966	50.38	51.28	877	44.97
21-33 d	49.25	1,850	91.11	50.52	1,811	91.49	49.60	1830	90.76	48.67	1,928	93.83
34-48 d	47.04	3,497	164.49	48.14	3,468	166.56	47.13	3699	174.33	46.12	3,433	158.32
TCF	303.57			307.8			315.47			297.12		
Final LW (g)	2,607			2,769			2,689			2,638		
CA / kg of LW	116.44 DZD	(€ 0.862)		111.15 DZD	(€ 0.823)		117.31 DZD	(€ 0.868)		112.63 DZD	(€ 0.834	
TPC / kg of LW	194.06 DZD	(€ 1.437)		185.25 DZD	(€ 1.372)		195.51 DZD	(€ 1.448)		187.71 DZD	(€ 1.39)	
CSE				322.43			313.11			307.18		
WD (DZD)				+ 18.86			+ 9.54			+ 3.60		
FD (DZD)				+13.80			-2.25			+9.95		
Difference (%)				-4.54%			+0.74			-3,27		

UP = Pi: unit price of 1 kg of feed (DZD); QI: quantity ingested (g) ; PQFI = Pi × Qi: price of quantity of feed ingested (DZD) TCF: total cost of feed; LW: live weight; TPC: total production cost; CSE: TCF that the farmer must spend on control feed to obtain experimental outputs; WD: difference in cost resulting from increased weight (DZD); FD: difference in cost resulting from reduced cost of feed (DZD)

Our economic results are similar to those obtained by Mourad (2017) and Kaci (2014); € 0.862/kg compared to € 0.875/kg and €0.852/kg respectively for animals fed on 100 % corn. For the experimental groups (20 % and 40 %), our feed costs are more advantageous than those obtained by these same authors: € 0.823/kg and € 0.834/kg compared to € 0.875/kg and €0.852/kg, respectively.

Production costs are higher than those recorded by Mourad (2017): (€ 1.32/kg) and the ITAVI (2015) (€ 0.962/kg) and similar to those obtained by Kaci (2014): (€ 1.42/kg) and the OFAAL (2015): (€ 1.37/kg).

For substitution to be rational, the production/cost ratio after substitution is equal to that before substitution, all other things being equal (Rejeb Gharbi and Benarif 2011):

$CP / Y = CP_1 / Y_1$

$(PX) / Y = [(P_1 X_1 + P (X - X_1)] / Y1$

$(PX)Y_1 / Y = [(P_1 X_1 + P (X - X_1)]$

$(PX)Y_1 / Y - P(X-X_1) = P_1 X_1 = (P X) [Y_1 / Y - 1] + P X_1$

$P_1 = (P X) [Y_1 / Y - 1] / X_1 + P$

$P_1 = P [(Y_1 / Y - 1) X / X_1 + 1]$, where

P1: Price of interest of the rejects of dates; P: price of foodstuff to be substituted (corn); Y1 / Y: production after substitution / production before substitution; X / X1: rate of substitution of production factors (corn / CD).

P =DZD 27/kg; X = 61% and Y = 2,607 g of meat

Table 9 shows that the price of cull dates used as a substitute for corn must not exceed DZD 27.80/kg. In our experimentation, the cost of CDs is DZD 12.572/kg.

Table 9. Interest price of cull date according to the substitution rate

	20%	**30%**	**40%**
X1	12.2	18.3	24.4
Y1 (g)	2,769	2,689	2,638
P1 (DZD/Qx)	3,538.89	2,982.8	2,780.26

CONCLUSIONS

Incorporating cull dates at a 40 % substitution rate instead of corn, with the addition of 250 ml of rumen content extract per kilogram of feed, improves live weight and average daily gain with a reduced quantity of food ingested and a lower consumption index. The characteristics of the carcasses remain unchanged. The diet with a 20% substitution rate proved to be more profitable than the 30% and 40% diets from a technical and economic standpoint (LW = 2,769 g and PC = € 1.37/kg), although the latter remain competitive compared to the control group.

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