

## **ECONOMICAL AND NUTRITIONAL EVALUATION OF REPLACING CORN GRAINS WITH CRASHED MACARONI AS UNCONVENTIONAL ENERGY SOURCE IN GROWING CALVES RATIONS.**

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### **SUMMARY**

**T**o study the effect of replacing corn grains with different levels of crashed macaroni in growing calves rations on the growth performance, twenty four growing Holstein male calves (8 - 9 months old and 208.65 ±3.6 kg live body weight) were used in a feeding trial for 100 days. Calves were divided into four similar groups (6 in each) according to live body weight and randomly fed one of the following rations: 55% corn grain, 10% soybean meal, 10% cotton seed meal, 4% wheat bran, 20% wheat straw and 1% minerals mixture (R1, control). Corn grains in the control ration, were replaced by crashed macaroni for R2, R3 and R4, at the level of 20, 40 and 60% respectively. At the end of the growth trial, three animals from each group were used in digestion trial to evaluate the nutrients digestibility and rumen activity.

There were no significant ( $P < 0.05$ ) differences among groups in the nutrients digestibility, except there was a linear increase in crude protein digestibility with increasing crashed macaroni level in the rations. There were no significant ( $P < 0.05$ ) differences among groups in TDN and DCP, being (64.32 and 8.25%), (65.40 and 8.54%), (66.23 and 8.91%) and (67.32 and 9.50%), for R1, R2, R3 and R4, respectively. There were insignificant ( $P < 0.05$ ) differences among groups in some rumen parameters, where values of pH; rumen ammonia and rumen volatile fatty acids were: 6.40, 6.41, 6.43 and 6.45; 12.49, 12.51, 12.60 and 12.65 mg/dL and 13.19, 15.02, 16.10 and 16.83 mmol/dL, for R1, R2, R3 and R4, respectively. The highest average daily body weight gain (1.310 kg/d) was recorded for R4 while, the highest feed conversion efficiency was recorded for R1 and R2 being 5.20 g feed/g gain in both. However, the lowest feed cost per one kilo gram gain was recorded with R4 followed by R3 and R2 then R1, being 8.92, 9.20, 9.49 and 10.11 L.E., respectively.

From the previous results, corn grains could be replaced with crashed macaroni in growing Holstein male calves ration up to 60% to reduce the feed cost without adverse effect on growth performance.

**Keywords:** *macaroni, corn, calves, growth*

### **INTRODUCTION**

The continuous increases in feed costs specially corn grains, owing to the import from abroad and being used as a source of energy for human (biofuel), led to search for other alternative feedstuffs or by-products. Macaroni by-products are the by-products of macaroni factories which are unsuitable for human consumption due to its disagreement with the Egyptian Organization for Standardization, 1970. Macaroni by-product is generally high in carbohydrates content and thus could be used as an excellent source of energy for animal feeds. This by-products were previously used as an alternative energy source in poultry rations (Ranhortra *et al.*, 1984 and 1985, and Abdel-Malak, 1988). But, there are narrow limiting informations about the use of macaroni by-product in ruminant rations. However, there are many attempts have been done to use other alternative energy sources in ruminant rations like cassava chips (Khampa and Wanapat, 2006 and Chanjula *et al.*, 2007) or dried citrus pulp (Gholizadeh and Naserian, 2010).

So, the aim of this study was to evaluate the impact of replacing corn grains with different levels of crashed macaroni on growth performance of calves.

## MATERIALS AND METHODS

### *Feeding trial:*

Twenty four growing Holstein male calves with average of 8 - 9 months old and 208.65 ±3.6 kg live body weight were used in feeding trial for 100 days. Animals were divided into four similar groups (6 of each) according to live body weight. Each group was randomly fed one of the following experimental rations: R1, control ration, (which consisted of 55% corn grain, 10% soybean meal, 10% cotton seed meal, 4% wheat bran, 20% wheat straw and 1% minerals mixture); R2, R3 or R4. Where corn grains in the control ration were partially substituted by crashed macaroni at the level of 20%, 40% and 60% in R2, R3 and R4, respectively. All experimental calves were fed on at 2.5% of their body weight, twice daily in two equal portions at 8.00 a.m. and 2.00 p.m. Feed intake and body weight changes of the animals were biweekly recorded during the experimental period, meanwhile offered feeds were biweekly adjusted according to the body weight changes. Animals were raised under hygienic and managerial conditions. Fresh water and mineral blocks were available at all time through the experimental period.

### *Digestibility trial:*

At the end of the feeding trial, three animals from each group were used to determine nutrients digestibility. Acid insoluble ash (AIA) was used as an internal marker according to Van Keulen and Young (1977) for determining nutrients digestibility according to the following equation:

$$\text{Digestion coefficient of nutrient} = 100 - \frac{\% \text{ indicator in feed}}{\% \text{ indicator in feces}} \times \frac{\% \text{ nutrient in feces}}{\% \text{ nutrient in feed}} \times 100$$

Samples of feces were taken for five successive days from each animal and sprayed with 10% sulphuric acid and 10% formaldehyde solutions and dried at 60°C for 24 hrs. Samples were mixed and stored for chemical analysis. Composite samples of feeds and feces were finely ground prior to analysis. The nutritive values as total digestible nutrients (TDN) and digestible crude protein (DCP) of the experimental rations were calculated.

### *Rumen fluid characteristics:*

At the end of feeding trial, rumen fluid samples were collected for three successive days from all animals using stomach tube attached with vacuum pump, before feeding and then at 3 and 6 hrs. post feeding. Sample of rumen content, for each animal, was taken just after sampling and filtered through four layers of cheesecloth, and then ruminal pH was immediately recorded using digital pH meter. Then, the samples were kept by frozen for ruminal parameters determination.

### *Analytical procedures:*

Representative samples of feed ingredients and feces were analyzed for summative analysis according to A.O.A.C. (1995). Ruminal ammonia nitrogen (NH<sub>3</sub>-N) concentration was determined according to Conway (1962). Ruminal total volatile fatty acids (TVFA's) concentration was determined according to Kromann *et al.*, (1967).

### *Statistical analysis:*

Data collected for digestibility, feeding trials and ruminal parameters were subjected to statistical analysis as one way analysis of variance using SAS (1998). Duncan's multiple range test (Duncan, 1955) was used to separate means when the dietary treatment effect was significant.

## RESULTS AND DISCUSSION

Chemical analysis of feed ingredients (Table 1) showed that there was a similarity in the chemical composition between corn grains and crashed macaroni especially in OM, EE, CF and ash being (98.52 and

98.39%), (6.36 and 6.67%), (2.39 and 2.07%) and (1.48 and 1.61%), respectively. While, CP content was higher (12.87%) in crashed macaroni than that in corn grains (9.32%). This might be due to the semolina flour which used in macaroni processing. This semolina is coarse-ground flour from the heart, or endosperm, of durum wheat, amber-colored high protein hard wheat that is grown specifically for the manufacture of pasta (Bannon, 1994). However, corn grains were higher in NFE (80.45%) than crashed macaroni (76.78%). Chemical composition of crashed macaroni is in agreement with this of Ghazalah *et al.*, 1993. Generally, the chemical analysis of certain feed ingredients was in the same trend of those obtained by Farghaly *et al.*, (2003) and Omer *et al.*, (2008 and 2009). Experimental rations components and chemical composition are presented in Table (2) mentioned that the experimental rations were similar in its chemical composition but there was a slight increase in the crude protein content with increasing the percentage of crashed macaroni replacement. This increase might be due the slightly increase of protein content in crashed macaroni than that in corn grains. On the other hand, control ration detected the highest NFE content compared with crashed macaroni rations as a result that corn grains contained NFE higher than that in crashed macaroni.

**Table (1): Chemical composition of feed ingredients (% DM basis).**

Feed ingredient	Chemical composition, %					
	OM	CP	EE	CF	NFE	Ash
Corn grains	98.52	9.32	6.36	2.39	80.45	1.48
Soybean meal	92.51	47.57	1.72	6.09	37.13	7.49
Cotton seed meal	94.44	27.78	5.56	25.55	35.55	5.56
Wheat bran	93.56	17.24	4.59	11.03	60.70	6.44
Crashed macaroni	98.39	12.87	6.67	2.07	76.78	1.61
Wheat straw	91.11	3.56	1.11	44.67	41.77	8.89

**Table (2): Rations components and chemical composition (% DM basis).**

Item	rations			
	R1 (control)	R2	R3	R4
Ingredients, %				
Corn grains	55	44	33	22
Crashed macaroni	---	11	22	33
Soybean meal	10	10	10	10
Cotton seed meal	10	10	10	10
Wheat bran	4	4	4	4
Wheat straw	20	20	20	20
Minerals mix.	1	1	1	1
Chemical composition, %				
OM	94.85	94.83	94.82	94.80
CP	14.08	14.47	14.86	15.25
EE	4.63	4.67	4.70	4.73
CF	13.85	13.82	13.78	13.75
NFE	62.30	61.89	61.49	61.09
Ash	4.15	4.17	4.18	4.20

**Digestibility trials:**

Data of nutrients digestibility and nutritive values of experimental rations are presented in Table (3). There were no significant ( $P < 0.05$ ) differences among groups in the nutrients digestibility. This result might be due to the lack of differences among groups in the chemical composition. But, it could be noticed that there was an increase in the digestibility of crude protein with increasing crashed macaroni substitution in rations. This increase might be due to the slightly increase of crude protein in crashed macaroni than corn this result agree with findings of Songsak *et al.*, (2009) who found that an increase in protein digestibility of heifers with increasing dietary crude protein levels. Results of nutrients digestibility were reflected on the nutritive values,

so there was no significant ( $P<0.05$ ) difference among groups in TDN and DCP being (65.78 and 8.25%), (65.78 and 8.54%), (65.86 and 8.91%) and (64.58 and 9.50%), respectively for R1, R2, R3 and R4.

**Table (3): Effect of rations feeding on nutrients digestibility and nutritive value.**

Item	Rations				± SE
	R1	R2	R3	R4	
Digestion coefficients, %					
DM	65.94	64.03	63.16	61.75	3.61
OM	65.29	64.69	64.11	62.28	4.67
CP	58.62	58.99	59.95	62.31	4.05
EE	63.02	65.88	68.52	70.72	6.85
CF	62.03	62.45	62.84	62.96	2.52
NFE	65.66	66.75	67.36	68.01	6.67
Nutritive value, %					
TDN	64.32	65.40	66.23	67.32	2.31
DCP	8.25	8.54	8.91	9.50	1.65

**Rumen fluid parameters:**

Data concerning the effects of experimental rations on rumen fluid parameters are presented in Table (4). All of the rumen parameters measured were had the normal ranges with time sampling and were in normal range of healthy animals. There were insignificant ( $P<0.05$ ) differences among groups in all of measured rumen parameter being (6.40, 6.41, 6.43 and 6.45) pH, (12.49, 12.51, 12.60 and 12.62 mg/dL)  $\text{NH}_3\text{-N}$  and (13.19, 15.02, 16.10 and 16.83 mmol/dL) TVFA's for R1, R2, R3 and R4, respectively. But it was noticed that increasing crushed macaroni levels leads to increasing ruminal  $\text{NH}_3\text{-N}$  and TVFA's concentration these might be due to higher starch digestion in crushed macaroni than corn as a result of steam and pressure effect during macaroni processing as indicated by Fred and Steven (2007) that processes including steam rolling, steam flaking and fermentation usually increase digestion in the rumen. Also, Rotger *et al.*, (2006) indicated that a synchronized rapid fermentation diet (barley-sunflower meal) tended to result in greater VFA concentration compared with a synchronized slow fermentation diet (corn- soybean meal).

**Table (4): Effect of experimental rations on some rumen activity of growing calves.**

Item	Time of sampling	Rations				±SE
		R1	R2	R3	R4	
pH	0	6.45	6.46	6.44	6.46	
	3	6.17	6.19	6.20	6.21	
	6	6.60	6.58	6.65	6.68	
	mean	6.40	6.41	6.43	6.45	0.11
$\text{NH}_3\text{-N}$ (mg/dl)	0	10.23	10.27	10.37	10.40	
	3	15.22	15.25	15.30	16.12	
	6	12.02	12.01	12.13	11.43	
	mean	12.49	12.51	12.60	12.65	1.33
TVFA's (mmol/dl)	0	11.61	12.98	13.40	14.85	
	3	15.25	17.21	17.95	18.23	
	6	12.71	14.87	16.95	17.41	
	mean	13.19	15.02	16.10	16.83	1.89

**Growth performance and economic evaluation:**

Data in Table (5) indicated that there was insignificant ( $P<0.05$ ) differences among groups in the average daily body being 1.303, 1.305, 1.307 and 1.310 kg/day for R1, R2, R3 and R4, respectively. Total dry matter intake was slightly increased with increasing crashed macaroni level in tested rations being 6.770, 6.780,

6.810 and 6.850 kg/h. /d. for R1, R2, R3 and R4, respectively. There was no difference among groups in TDN intake per metabolic body weight being 0.067, 0.066, 0.068 and 0.069 kg/kg w<sup>0.75</sup> for R1 R2, R3 and R4, respectively. The same trend was observed for DCP intake being 0.559, 0.579, 0.607 and 0.651 kg/h./d<sup>-1</sup>, in the same order.

**Table (5): Effect of rations feeding on growing calves performance.**

Item	Rations				± SE
	R1	R2	R3	R4	
<u>A) Live body weight:</u>					
Initial live body weight, kg	205.7	205.8	203.7	204.7	13.74
Final live body weight, kg	336	336	334	335.7	23.51
Total body weight gain, kg	130.3	130.5	130.7	131	17.94
Daily body weight gain, kg	1.303	1.305	1.307	1.310	0.178
<u>B) Feed intake:</u>					
Concentrate, kg/h. /d <sup>-1</sup> .	5.416	5.424	5.448	5.480	
Wheat straw, kg/h. /d <sup>-1</sup> .	1.354	1.356	1.362	1.370	
DMI, kg / h/d <sup>-1</sup> .	6.770	6.780	6.810	6.850	
DCP intake, kg/h./d <sup>-1</sup> .	0.559	0.579	0.607	0.651	
TDN intake, kg/h./d <sup>-1</sup> .	4.445	4.434	4.510	4.605	
TDN, kg / kg w <sup>0.75</sup>	0.067	0.066	0.068	0.069	
<u>c) Feed conversion</u>					
DMI (g feed/ g gain)	5.20	5.20	5.21	5.23	
<u>D) Economic evaluation</u>					
Total feed cost/day, L.E.	13.17	12.38	12.03	11.69	
Feed cost/kg gain, L.E.	10.11	9.49	9.20	8.92	

*Prices of corn, soybean meal, cotton seed meal, wheat bran, crashed macaroni pasta and mineral mix at 2006. were 1800, 2800, 2300, 1650, 1000 and 5000 L.E. /ton, respectively.*

The same trend was observed for feed conversion efficiency (g feed/g gain) among groups being 5.20, 5.20, 5.21 and 5.23 for calves fed R1, R2, R3 and R4, respectively. The lowest feed cost per one kilo gram gain was recorded with R4 followed by R3 and R2 then R1, being 8.92, 9.20, 9.49 and 10.11 L.E. respectively.

From the previous results, corn grains could be replaced with crashed macaroni in growing calves ration up to 60% to reduce feeding cost without advertise effect on growth performance.

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## التقييم الإقتصادي والغذائي لاستبدال حبوب الذرة بكسر المكرونة كمصدر طاقة غير تقليدي في علائق العجول النامية

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لدراسة تأثير استبدال الذرة بمستويات مختلفة من كسر المكرونة في عليقة العجول النامية على كفاءة النمو، تم إجراء تجربة تغذية لمدة 100 يوم باستخدام 24 عجل هولشتاين نامى متوسط عمر 8-9 شهور وبمتوسط وزن حي 208.65 كجم. قسمت العجول الى 4 مجاميع (6 عجول بكل مجموعة) تبعاً للوزن الحى، ثم وزعت المجاميع عشوائياً لتغذى كل مجموعة على أحد العلائق التجريبية وهى: عليقة الكنترول (مج 1) وتتكون من 55% حبوب ذرة، 10% كسب فول صويا، 10% كسب فطن مقشور، 4% ردة، 20% تبن قمح و 1% مخلوط عناصر معدنية، ثم تم عمل استبدال جزئى للذرة (20، 40، 60%) بكسر المكرونة فى مج 2، مج 3، مج 4 على التوالى. وفى نهاية تجربة النمو تم استخدام 3 حيوانات من كل مجموعة فى تجربة هضم لتقدير معاملات الهضم وبعض مقاييس الكرش.

أوضحت النتائج عدم وجود فروق معنوية بين المجاميع التجريبية فى معاملات هضم العناصر الغذائية مع ملاحظة وجود زيادة تدريجية فى معاملات الهضم مع زيادة مستوى كسر المكرونة فى العليقة. كذلك لم يكن هناك أى فروق معنوية بين المجاميع التجريبية فى القيمة الغذائية للعلائق فى صورة مركبات غذائية مهضومة كلية أو بروتين مهضوم حيث كانت القيم المسجلة (64.32، 68.25%)، (65.40، 8.54%)، (66.23، 8.91%)، (67.32، 9.50%) للمجموعات مج 1، 2، 3، 4 على التوالى. لم يكن هناك فروق معنوية لقياسات الكرش بين المجاميع التجريبية حيث كانت (6.40، 6.41، 6.43، 6.45) لحموضة الكرش، (12.49، 12.51، 12.60، 12.65 مللى مول/ديسيلتر) لأمونيا الكرش، (13.19، 15.02، 16.10، 16.83 مللى مول/ديسيلتر) للأحماض الدهنية الطيارة بالكرش للمجاميع مج 1، 2، 3، 4 على التوالى.

أعلى معدل زيادة يومية فى الوزن (1.31 كجم/يوم) سجلت فى المجموعة الرابعة، بينما أعلى قيم تحويل غذائى كان (5.20 جم مكول/جم زيادة وزنية) سجل فى المجموعتين مج 1، مج 2. وكانت التكلفة الغذائية لكل 1 كجم زيادة وزنية 8.92، 9.20، 9.49، 10.11 جنية للمجموعات مج 4، 3، 2، 1 على التوالى، أى أنه بزيادة محتوى العليقة من كسر المكرونة تقل تكلفى التغذية لكل وحدة زيادة وزنية.

وبناءً على النتائج المبينة فأنه يمكن استبدال الذرة بكسر المكرونة فى علائق العجول النامية حتى 60% لتقليل تكلفة التغذية دون تأثيرات سلبية على كفاءة النمو.