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# Evaluation of cactus cladodes as a partial feed for growing rabbits in the Gaza Strip

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## Abstract

To evaluate use of cactus *Opuntia* cladodes *(COC)* under unavoidable conditions as a partial feed *on* the growth performance, organs and carcass weights of growing rabbits under small scale growth conditions. The study design was a case-control. It was carried out on the local weaned rabbits (n=48), aged 35-40 days and average initial live weights was about 550 g. The period of study was 8 weeks. The rabbits were classified randomly to four different groups. One was a control group and the others were case groups. The control group (C) was fed ad libitum on only high protein pellets, which is commercially called Anber (RPA). Case groups were labeled trial 1 (T1), trail 2 (T2), and trial 3 (T3) and were fed ad-libitum COC and 80 %, 60 % and 40 % RPA, respectively. The actual nutrient contents of the two feeds were examined in Al-Azhar University food analysis labs. SPSS system was used to analyze data.

COC feed was found to be poor in crude protein. Dry matter values for RPA and COC were 86.4 % and 16.0 %, respectively. COC had lower crude fibers, fats, and nitrogen free extract than RPA. The growth rates of the growing rabbits were 26.31, 21.20, 18.56, and 10.64 g/day for C, T1, T2, and T3 trials, respectively. Feed conversion ratios based on RPA consumption were 3.33, 3.01, 2.85, and 3.25, for C, T1, T2, and T3 trials, respectively. Partial COC feed decreased average weights of internal body fat tissues and some organs of the rabbits. In contrast, 40 % RPA diet and ad libitum COC feed increased average of liver weights of the rabbits.

*It can be concluded that domesticated rabbits can tolerate ad-libitum COC as a partial feed of RPA diet under unavoidable conditions.*

*Key words: Cactus Opuntia cladodes, rabbit pellets, rabbits, small-scale growth conditions.*

## Introduction

Rabbits production is beneficial mainly in the rural and sub urban areas under management system with pellet-based feeds as the principle feed sources. The high cost of the commercial concentrated diets limits the successful production of rabbits in the Gaza Strip (El-Shawa 1988). Feeding of rabbits has a strong influence on breeding, fertility, conception, kindling, nursing, growth, and resistance to disease. However, a well balanced, palatable diet should be available to rabbits at all times in amounts which will adequately supply their nutritional needs. Weaned growing rabbits require about 100 g RPA/ day and other supplements are not needed (El-Shawa 1988).

Rabbit meat is one of the most nutritious meats available. It is highest in protein of high quality, lowest in fat and cholesterol, has the least number of calories per pound and has only 8 percent bone (Jones 1990). Unlike wild rabbit, domesticated rabbit meat is pearly white, tender, juicy and mild in flavor (Handa et al 1995).

*Opuntia* used throughout this study refer to the whole genus, of which the most widely known is *Opuntia ficus-indica*. Previously, *Opuntia* was used almost interchangeably with cactus pear and prickly pear. Cactus is a desertification plant and a highly palatable to wild and domesticated rabbits (Hoffman et al 1993; Felker 1995). This plant resists diseases, tolerates a variety of climate conditions and excessive cutting (Ruiz-Feria et al 1996).*Opuntia* have become an endless source of products and functions, initially as a wild plant and, later, as a crop for both subsistence and market-oriented agriculture, contributing to the food security of populations in agriculturally marginalized areas (Nobel 1995; Felker 1995).

COC feed is documented to be high in moisture content and low in dry matter (Gregory and Felker 1992). It can provide a good complement when fed to Livestock in combination with semi-arid adapted, nitrogen–fixing, and high protein plants such as leucaena and mesquite (Russell and Felker 1987). Ruiz-Feria et at (1996) evaluated growth rate of New Zealand white rabbits using COC and Mesquite (*Prosopis Glandosavar. Glandulasa*) as forage sources. They found that rabbit fed 50 % cactus were 293 g heavier than rabbits fed 50 % mesquite ($p<0.01$) because mesquite had low observed palatability compared to cactus. Ruiz-Feria et al (1998) also evaluated rabbit growth performance using leucaena and cactus forages. They reported that leucaena fed rabbits had the poorest performance, but when fed with 10 % level cactus, growth and carcass traits were improved.

Nevertheless, feed is very important for raising rabbits because it accounts for most of production costs. In the Gaza strip, most people are very poor and domesticated rabbits eat a very expensive commercial high protein pellets (e.g. RPA) that are irregularly imported from Israel due to the chronic political problems. These pellets are not made in the Gaza strip because of lack of lyophilized hay materials. Moreover, information is limited in the literature on the response of growing rabbits to COC as partial replacement of concentrated high protein feeds. The main objective of this study, therefore, is to evaluate the use of prickly pear cactus as a partial replacement of the commonly used RPA diet on growth, carcass, and organs weights performances of growing local weaned rabbits.

## Material and methods

The study design was a case-control. The case groups were the rabbits that fed ad libitum COC and partial amounts of RPA diet. The control group was only fed RPA diet. Both groups matched each other in initial body weight, water supplementation, and all other environmental conditions.

The hypothesis under investigation was that whether rabbits partially fed RPA and ad libitum COC were more likely to have growth rate, carcass and body organs weights to those rabbits fed only RPA.

The experiment carried out at rabbit unit of Khalil Abu-Shamalah's Farm, El-Zwadia Town, Mid-Zone Governorate, Gaza. It started at April 2006 and ended at June 2006.

Forty-eight local weaned rabbits of mixed breed and sexes used for this study were purchased at 35-40 days of age from the General Economic Consumer Establishment, El-Sakhra, Gaza. To commence the trial, the rabbits were weight individually and distributed into 4 groups of similar average initial live weights of about 550 g. The period of study was 8 weeks. The rabbits housed in metallic cages provided with feeder and drinking cups. The area of each cage was 0.35 $m^2$. Housing and other management practices maintained similar for all treatment groups.

The rabbits assigned into 3 case groups and one control group with 6 replications of two rabbit each. Animals on each treatment diet randomly allocated to cages in a manner to ensure equitable treatment distribution within the farm. The farm was well aerated and sun lighted.

The C group was fed ad libitum RPA diet. T1, T2, and T3 case groups were fed diets consisted of ad-libitum COC and 80 %, 60 %, 40 % RPA, respectively. Throughout the study, the restricted feeding levels of cases were determined based on consumption of the control rabbits in the previous day. In addition, wild typed COC middle aged (1-2 years) were harvest daily from the same research plot and were placed randomly as small squared spineless cactus pads in the rabbit forage feeders on the same day of collection. Water provided continuously with tetracycline (1gm/l) for 1$^{st}$ two weeks to protect the rabbits from bacterial infection. All feeds will be offered in the morning after collection of the left over. Live weight change recorded weekly until the end of the trail. Feeds offered and the left–over recorded daily for each treatment to determine average daily feed intake. Feed conversion ratio was determined by dividing the value of average daily feed intake (based on RPA consumption) by that of average daily live weight gain for each study group.

For organs and carcass evaluation, four rabbits at age 60 days were selected from each study group for slaughtering based on average weight. Before slaughtering, the animals were starved overnight to clear the guts and the live weights were recorded. The skin with fur was removed carefully. Evisceration of the carcasses was carried out and the internal organs were weighted separately and expressed as an average and a standard error of mean (SEM). Head, feet and tail were removed to obtain the dressed carcass weight.

The actual nutrient contents of the two feeds were examined in Al-Azhar university food analysis labs. All obtained data were analyzed by ANOVA using SPSS system (Version 13). Difference between variables was considered statistically significant if p value $< 0.05$.

## Results and discussions

Table 1 shows the chemical composition of the RPA diet. The analysis of RPA diet was compared with ingredients percentage shown on the commercial label. There was a clear decrease in the actual concentrations of the total crude protein (CP), crude fibers (CF) and ash. In contrast, there was a clear increase in the actual concentration of salt and Mg.

**Table 1.** Percentage of chemical composition of RPA

| Ingredients | *labeled | **tested |
|---|---|---|
| Total protein | 17.0 | 12.7 |
| Water | 13.0 | 13.6 |
| Total fats | 3.5 | 3.41 |
| Fibers | 10.5 | 6.81 |
| Ash | 7.5 | 5.0 |
| Calcium | 0.80 | 0.67 |
| Phosphorous | 0.60 | 0.51 |
| Salt | 0.65 | 1.31 |
| Mg (mg/kg) | 0.04 | 0.06 |

*Along with it contain Nitrogen free extracts, vitamins, and some mineral.*
**According to the commercial label*
***According to results of Al-Azhar University Food Analysis Labs. The values given are average of duplicate samples*.

Table 2 shows the chemical compositions of the COC used for partial feeding of the growing rabbits. It is clear that COC feed is poor in crude protein and rich in water. According to tables1 and 2, dry matter (DM) values for RPA and COC were 86.4 % and 16.0 %, respectively.

**Table 2.** Chemical composition of COC (% wet basis)

| Ingredients | COC, %* |
|---|---|
| Moisture | 84.0 |
| Crude protein | 8.7 |
| Crude fibers | 2.9 |
| Fat contents | 0.02 |
| Ash | 1.2 |
| Carbohydrates | 7.0 |
| Nitrogen free extract | 10.9 |
| Calcium, mg/kg | 11.0 |
| Iron, mg/kg | 1.3 |

**The values given are average of duplicate samples*

These findings about general percentage of COC composition are consistent with those reported by Gregory and Felker 1992 and Nefzaoui 1995. They found that CP content of the cactus is lower than 5 % of DM. In this study, COC had also lower CF, fats, nitrogen free extract and ash than RPA. In contrast to these findings, Ruiza-Feria et al (1998) reported that COC (% DM basis) contains 9.3 % CP and 10.5 % CF. Nefzaoui and Ben Salem (2005) reported that the average value of CF and ash are about 10 % and 20 of the DM, respectively. These contradictions of results about CP, CF, and ash contents of COC indicate that chemical composition of COC are very heterogeneous depending on COC surrounding environmental conditions and age. However, Gonzalez (1989) reported that N and P fertilizers increased CP content of COC from 4.5 % to 10.5 % of DM. Moreover, Retamal et al (1987) reported that the CP contents decrease (5 to 3 % DM) and CF increase (9 to 20 % DM) when COC' ages move from 1 to 5 years.

COC also contain micro-amounts of calcium more than iron (Table 2). In agreement with this finding, recent investigations have shown that COC are rich in calcium solutes and poor in other minerals such as K, P, and Na (Nefzaoui 1995; Nefzaoui and Ben Salem 2005).

Table 3 shows that average of final body weights of the rabbits aged 56 days decreased significantly with decreasing percentage of RPA diet ($p< 0.05$).

**Table 3.** Effect of partially COC intakes on average (SEM) growth performances of the grower rabbits

| **Average body weight** | **Dietary group** | | | | |
|---|---|---|---|---|---|
| | **C** | **T1** | **T2** | **T3** | **P** |
| Initial, g | 551±0.18 | 548±0.15 | 555±0.20 | 550±0.17 | NS |
| Final, g | 2,024 ± 0.21[a] | 1,740 ± 0.10[b] | 1,600 ± 0.14[c] | 1,150[d] ± 0.20[d] | S |
| Total, g | 1473 ± 0.01[a] | 1188 ± 0.02[b] | 1040 ± 0.36[c] | 596 ±0.38[d] | S |
| Growth rate, g/day | 26.31± 0.02[a] | 21.20±0.03[b] | 18.57±0.27[c] | 10.64±0.31[d] | S |

*Means with difference superscripts in the same row differ significantly ($p <0.05$)*

The highest growth rate on the RPA diet would appear to be logical consequence of the superior amino acids balance of this complete protein diet, compared with COC feed. Average final body weights for T1 and T2 were 1740 g and 1600 g, respectively. These weights were considered acceptable for marketing and slaughtering. The average final body weights of C was 2024 g . This value can be obtained by increasing age of the growing rabbits of T1 and T2 a few days. However, growth rates of the rabbits were 26.31, 21.20, 18.57, and 10.64 g/day in average for the C, T1, T2, and T3, respectively. Thus, the growth rate of the rabbits was in the range of 10 to 26 g/day. The RPA diet as a sole source of supplementary protein gave the highest growth rate compared to many other high protein concentrate feeds reported in the literature (Rahim et al 1997; Roy et al 2002; Amaefule et al 2005; Mbanya et al 2005; Orunmuyi et al 2006; Onimisi and Omage 2006). These differences in average of growth rates of the rabbits may be due to variations in age, genotypes, and different environmental conditions.

Table 4 shows that average daily RPA diet intakes of the C, T1, T2, and T3 trials were 87.6, 63.8, 53.0, and 34.6, respectively. Thus, It appears that the differences in the growth rates were due to the differences in the daily RPA diet intakes of the growing rabbits. However, feed conversion ratios based on RPA diet consumption for C, T1, T2, and T3 were 3.33, 3.01, 2.85, and 3.25, respectively.

**Table 4.** Average (SEM) RPA intake and feed conversion ratio of growing rabbits partially fed ad-libitum COC

| Parameters | Dietary groups | | | | |
|---|---|---|---|---|---|
| | C | T1 | T2 | T3 | P. Value |
| Initial RPA, g | 56 ± 0.23[a] | 40 ± 0.22[b] | 31± 0.20[c] | 23[d] ± 0.12 | S |
| Final RPA, g | 115 ± 0.13[a] | 79 ±0.29[b] | 70 ±0.11[c] | 45 ±0.02[d] | S |
| Average daily Intake, g | 87.60 ± 0.17[a] | 63.80 ± 0.25[b] | 53.00 ± 0.17[c] | 34.60 ± 0.08[d] | S |
| Feed conversion | 3.33 ± 0.25[a] | 3.01 ± 0.016[b] | 2.85 ± 0.15[c] | 3.25 ± 0.01[a] | S |

*Means with difference superscripts in the same row differ significantly (p <0.05)*

The slight difference of feed conversion between C and T1 or T2 reflects slower growth rate and higher sparing of costly RPA diet. No significant difference of feed conversion between C and T3 was observed (p> 0.05) because the daily intake of RPA diet in T3 trial was 40 % of C. Thus, feed conversion ratios based on RPA diet intake did not reflect true growth efficiency of the growing rabbits, and COC feed played a minor role in the growth rate. In T1 trial, rabbits consumed about 70 % of their diet from RPA and about 10 % of it was left over. Thus, COC is highly palatable for growing rabbits. This finding is very consistent with those reported by Gregory and Felker (1992). Moreover, during the experiment only 1, 3, 3, and 2 rabbits died in C1, T1, T2, and T3 trials, respectively. Surprisingly, 2 rabbits only died in T3 trial indicating that domesticated growing rabbits can tolerate partially COC feed under unavoidable conditions.

Results of body organs and carcass characteristics (Table 5) showed that skin, head, and kidneys/spleen/lungs are significantly different between C, and T1 or T2 and T3. T1 and T2 trials did not differ in average of these organs weights.

**Table 5.** Effect of partially COC intake on some average (SEM) organs weight, body fat and carcass weight of the growing rabbits at slaughtering age (60 days).

| Average organs and carcass wt, g | Dietary groups | | | | |
|---|---|---|---|---|---|
| | C | T1 | T2 | T3 | P |
| Skin | 206±0.12[a] | 137±0.18[b] | 134 ±0.12[b] | 108±0.21[c] | S |
| Head | 200 ±0.14[a] | 152 ±0.08[b] | 149 ± 0.13[b] | 129 ±0.03[c] | S |
| Legs | 85±0.09[a] | 58±0.08[b] | 64 ±0.14[c] | 47 ±0.12[d] | S |
| Vesira | 187 ±0.08[a] | 150±0.19[b] | 133± 0.02[c] | 111 ±0.11[d] | S |
| Liver | 61± 0.02[b] | 52 ± 0.21[b] | 52 ± 0.21[c] | 70 ± 0.18[a] | S |
| Kidney, Spleen and lungs | 49 ± 0.13[a] | 38 ± 0.11[b] | 39 ± 0.22[b] | 29 ± 0.21[c] | S |
| Carcass | 1070±0.14[a] | 798±0.20[b] | 726 ±0.03[c] | 568 ±0.23[d] | S |
| Internal body fat tissue | 8 ±0.19[a] | 4 ±0.38[b] | 3 ±0.38[c] | 2 ± 0.53[d] | S |

*Means with difference superscripts in the same row differ significantly (p <0.05)*

This significant difference in average liver weights was also observed among the trials. However, liver of T3 had the highest average weights that might be due to its involvement in COC digestion and metabolism. Other organs (legs and vesira), carcass, internal body fat tissues showed significant differences across the dietary treatments. Moreover, percentages of carcass/ body weight at the slaughtering age were 47.7, 44.5, 41.3 and 21 for C, T1, T2, and T3 trials, respectively. The slight difference in these values between C and T1or T2 indicated that T1 and T2 rabbits were very acceptable for marketing and slaughtering. Nevertheless, in general, partial COC feed succeeded in decreasing average of organs weights and average of internal body fat tissues weights of the rabbits. In contrast, 40 % RPA diet and ad-libitum COC succeeded to increase average of liver weights of the rabbits.

## Conclusion

Although partial RPA diets and ad-libitum COC affect significantly growth rate, organs and carcass weights of the domesticated growing rabbits, one can conclude that they can tolerate these combined feeds under unavoidable conditions in the Gaza Strip. Further studies are needed for final conclusion.

## Recommendations

In the Gaza strip, nowadays, rabbit farms undergo from deficiency of high expensive commercial concentrated feeds such as RPA that are usually imported from Israel and not made in the Gaza Strip. Therefore, rabbit farmers are looking for alternative feeds. The present study was a case-control and gave an indication that growing rabbits can tolerate COC as a partial feed of RPA diet under unavoidable conditions. It recommends studying the effect of partial COC feed on reproductive performances of domesticated rabbits. It also recommends carrying out histological studies of some organs particularly liver of the growing rabbits partially fed COC.

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