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# NUTRITONAL IMPACT OF USING CITRONELLA (*CYMBOPOGON NARDUS*) BY-PRODUCT WITH OR WITHOUT ENZYMES MIXTURE SUPPLEMENTATION ON GROWTH PERFORMANCE OF GROWING RABBITS.

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**ABSTRACT:** *Growth performance, carcass traits, nutrient digestibility coefficients, some blood parameters and economical evaluation of APRI growing rabbits to diets containing graded levels of citronella by-product (CBP) as a replacement of clover hay was studied in the current study. A total number of 80 APRI growing rabbits, 6 weeks of age weighing 703 g±6.43. Rabbits were randomly distributed into 5 groups, each had 16 rabbits in 4 replicates 4 rabbits, each. The first group was fed the basal diet and served as a control group, the second and third groups were fed diet contained (20% CBP) and (40% CBP) citronella by-product in replacement of clover hay and represent 5.86% and 11.72% of the whole diets, respectively. The fourth and fifth groups were fed the same previous levels of CBP, but supplemented with enzymes mixture (Natuzyme fortified; E) at level of 0.35 g/kg diet and labeled (20% CBP+E) and (40% CBP+E), respectively. Enzymes mixture contains 6000 U cellulose, 11000 U xylanase, 1500 U phytase, 700 U β-mannase, 700 U α-amylase and 700 U protease/ g. The results reveal that the group of 40% CBP+E achieved significantly the highest final weight with 5.8% improvement over the control and the best FCR than those of the control group, which was a associated with an increase in nutrients' digestibility coefficients' of CP, NFE and CF%, as well as enhancing carcass% and dressing %. In addition, 40% CBP+E group, recorded the cheapest price for producing 1 kg of rabbit meat and the best economic efficiency.*

*It could be concluded that inclusion of citronella (Cymbopogonnardus) by-product up to 11.72% plus enzymes mixture of the whole diet is effective in improving rabbit's growth performance in economic way.*

**Keywords:** Clover hay, Citronella, *Cymbopogonnardus*, by-product, growing rabbits, growth performance, enzyme mixture,

## INTRODUCTION

Cost of feed is the main factor affecting animal production, representing more than 70% of the total production cost. So, new unconventional local sources of low price ingredients need to be identified and validated.

Citronella grass plant has many common names such as ceylon citronella, giant turpentine grass and nard grass, it belongs to *Poaceae* family. This grass is grown in the tropical areas of Asia like Indonesia, Java, Burma, India and Sri Lanka (Paranagama*et al.,* 2003). Since 2006, cultivation of citronella grass succeeded in Egypt, for production of its essential oil. It could be noted that, per each 1000 kg of distilled citronella leaves, 8 kg of essential oil will be produced; remaining by-products (992 kg) are discarded as a waste (Manurung *et al.,* 2015), hence, this waste used for feeding domestic animals. Citronella by-product contains 5.4% crude protein, 34.2% crude fiber and 2.3% ether extract according to Rao *et al.* (1984), and has many medical benefits such as anti-bacterial, anti-microbial, and anti-fungal (Prabuseenivasan *et al.,* 2006). Also, it acts as antioxidant and growth promoter as reported by Shah *et al.* (2011).These effects may be due to that it contains some essential oils (such as geraniol (35.7% of total volatiles), *trans*-citral (22.7%), *cis*-citral (14.2%), geranyl acetate (9.7%), citronellal (5.8%) and citronellol (4.6%) according to Nakahara *et al.* (2003).and flavonoids (Lewis, 1986).In earlier research of Rosete *et al*. (1987) found that daily body weight gain of the holestein–friesian heifers improved by feeding either *cymbopogon citrates* or citronella bagasse forage comparing to control . In addition to Mohamed (2003) reported that feeding rabbits on *cymbopogon citrates* by- product at level of 10% of the diet improved daily body weight gain, feed intake, feed conversion ratio, digestibility coefficient of nutrients and dressing percentage compared to the control group. As citronella grass contains low crude protein, nitrogen free extract, and high crude fiber contents, addition of enzymes mixture is a suitable solution for this problem. In this respect, several studies have been reported that the use of enzyme mixture to improve the utilization of some plant by-products, Ibrahim *et al.*(2010) reported an enhancement in rabbit's performance by adding enzyme to diet containing date stone meal. Moreover, El-Manylawi and El-Banna (2013) concluded that replacing clover hay in rabbit's diet by 10 or 20% date stone meal with enzyme mixture improved growth performance comparing to control group.

Therefore, the aim of the present study was to investigate the effect of citronella by-product without or with enzyme mix on growth performance, carcass quality traits, and marketing price of growing rabbits.

## MATERIALS AND METHODS

The current study was conducted at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. A total number of 80 APRI growing rabbits, 6 weeks of age weighing 703g ± 6.43. Rabbits were kept in cleaned and fumigated cages of wire floored batteries in an open system house under similar conditions of management

***Preparation of citronella by-product (CBP)***

After extracting the oil from citronella grass, its by-product was air dried inside an empty room in the farm, turned over in morning and evening until complete dried then citronella by-product was grinded and packed till starting the experiment. The proximate analysis was done according to **AOAC (2000)** and DE with citronella by-product was calculated according to **Cheeke, (1987)** as follows:

DE (kcal/kg) = 4.36 – (0.0491× NDF%), Where NDF% = 28.924 + (0.657× CF%).

***Natuzyme fortified (E)***

Enzyme mixture used in this study was obtained from Bio proton pty Ltd., Australia. Each 1 g of enzyme mixture (E) used in this study contained: 6000 U cellulose, 11000 U xylanase, 1500 Uphytase, 700 U beta-mannase, 700 U alpha-amylaseand 700 U protease. This product was used at rate of 350g/ton.

Experimental rabbits were randomly distributed into 5 groups, each containing 16 rabbits in 4 replicates 4 rabbits each. The 1$^{st}$group served as the control group. In the other 4 groups, citronella by product (CBP) was used at levels of 20 or 40% in replacement of clover hay. Each level of CBP was used without enzyme supplementation (CBP) or supplemented with 0.35 g/kg diet enzyme mixture (CBP+E) as an attempt to improve the utilization of CBP in fattening rabbit diets. All groups were given iso-caloric and iso-nitrogenous diets for 8 weeks experimental period. Experimental diets were formulated according to RCFF (2001) (Table 1), also, formulated to satisfy the Agriculture Ministry Decree (1996) recommendations for growing rabbits. Water and pellet experimental feeds were offered *ad libitum*.

Rabbits were weighed in the beginning (6 weeks of age) initial body weight and at the end (14 weeks of age) final body weight of the growth trial also, feed intake was recorded biweekly. While, weight gain and feed conversion ratio (as g feed/ g gain), were calculated. At the end of the

**Table 1:** Feed ingredients and calculated analysis of the experimental diets.

| Ingredients | Control | 20% CBP | 40% CBP | 20% CBP+E | 40% CBP+E |
|---|---|---|---|---|---|
| Clover hay (12%) | 29.30 | 23.44 | 17.58 | 23.44 | 17.58 |
| CBP | ---------- | 5.86 | 11.72 | 5.86 | 11.72 |
| Wheat bran | 22.00 | 22.00 | 21.50 | 22.00 | 21.50 |
| Yellow corn | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 |
| Soybean meal (44%) | 20.00 | 20.00 | 20.50 | 20.00 | 20.50 |
| Vitamin and Mineral mix.* | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Di calcium phosphate | 2.00 | 2.00 | 2.00 | 2.00 | 2.20 |
| Sodium Chloride | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Limestone | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| DL-Methionine | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| Anticoccidia(Diclazuril) | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Molasses | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| **Total** | **100** | **100** | **100** | **100** | **100** |
| ***Calculated analysis %****** | | | | | |
| Organic matter | 90.28 | 90.10 | 89.80 | 90.10 | 89.80 |
| Crude protein | 17.55 | 17.53 | 17.42 | 17.53 | 17.42 |
| Crude fiber | 13.20 | 13.58 | 13.95 | 13.58 | 13.95 |
| Ether extract | 2.64 | 2.79 | 2.87 | 2.79 | 2.87 |
| Nitrogen free extract | 56.89 | 56.20 | 55.56 | 56.20 | 55.56 |
| Ash | 9.72 | 9.90 | 10.20 | 9.90 | 10.20 |
| DE( kcal/kg) | 2550 | 2551 | 2553 | 2551 | 2553 |
| Calcium | 1.22 | 1.15 | 1.10 | 1.15 | 1.10 |
| Total phosphorus | 0.84 | 0.83 | 0.82 | 0.83 | 0.82 |
| Lysine | 0.94 | 0.91 | 0.90 | 0.91 | 0.90 |
| Methionine | 0.62 | 0.61 | 0.61 | 0.61 | 0.61 |
| **Price/ Ton (LE)**** | **4643** | **4510** | **4380** | **4580** | **4450** |

CBP: Citronella by product .

* Each 1kg of feed contains:-Vit. A, 6000IU; Vit. $D_3$, 900 IU; Vit. E, 40mg; Vit. $B_1$, 2mg; Vit. $B_2$, 4mg; Vit. $B_6$, 2mg; Vit. $B_{12}$, 10mg; Niacin, 50mg ; Pantothenic acid, 10mg; Biotin, 50mg; Folic acid, 3mg ; Choline, 250 mg ; Zn, 50mg; Mn, 85mg; Fe, 50 mg; Cu, 5mg; I, 0.2 mg; Se, 0.1mg and Co, 0.1mg.

** price of 1kg of cetronella by-product = 0.75LE., price of 1kg of Natuzyme (enzyme mix)= 200LE

****According to Feed composition for animal and poultry feed stuff used in Egypt (2001).*

feeding trial, 20 rabbits, 4 of each treatment (one from each replicate) were randomly chosen and individually housed in metabolic cages to determine the nutrients digestibility and feeding values of dietary treatments. The analyses of feed and dried feces were done according to AOAC (2000).

At the end of the growth trial, 4 rabbits of each experimental group were overnight fasted then assigned for determining hot carcass, dressing, giblets (heart, liver and kidney) as proportioned to live weight of slaughtering. Twenty blood samples were taken into tubes without anticoagulant and centrifuged at 3000 rpm for 15 minutes to obtain serum that stored frozen at -20$^{o}$C until analyzed for total protein (TP; g/dl), albumin (g/dl), aspartate amino transferase (AST; u/l), serum alanine amino transferase (ALT; u/l), creatinin (mg/dl) according to Reitman and frankel (1957) and total cholesterol (mg/dl) according to Richmond (1973).

The price of producing 1 kg of meat was calculated by the following equation:

Price to produce 1 kg of meat (LE) = total feed cost (LE)/ total weight gain (kg) according to Bayoumi (1980).

The data obtained were statistically analyzed using SAS (2004) program with one-way analysis. The experimental model used was as follows:

$$Y_{ij} = \mu + T_i + e_{ij},$$

Where: $Y_{ij}$ = An observation, $\mu$ = Overall mean, $T_i$ = Effect of treatments, i (1 to 5), $e_{ij}$= Experimental error.

Duncan's multiple range test was used to detect any significant differences between the experimental means (Duncan, 1955).

## RESULTS AND DISCUSSIONS

### *Proximate analysis of citronella by- product (CBP) and clover hay*

Chemical analysis of citronella by- product (CBP) compared to clover hay are presented in Table 2, citronella by product (CBP) contains 91.29% OM; 5.96% CP; 36.62% CF; 3.30% EE; 45.41% NFE; 8.71% ash and 1759 kcal/kg diet DE. While, the chemical analysis of clover hay is as follows: 91.20%, 12.00, 30.00%, 2.10%, 47.10%, 8.80% and 1780 kcal/kg for OM, CP, CF, EE, NFE, ash and Digestible energy, respectively according to Feed Composition for Animal and Poultry Feedstuff used in Egypt (RCFF, 2001). This result agrees with Rao *et al*. (1984) who found that citronella by product contains: 5.40% CP; 34.20% CF, and 3.20% EE.

**Table 2.** Chemical composition of citronella by- product and clover hay (on DM basis).

| Items | Chemical analysis% (on DM basis) | | | | | | |
|---|---|---|---|---|---|---|---|
| | OM% | CP% | CF% | EE% | NFE% | Ash% | DE (Kcal/kg) |
| **CBP** | 91.29 | 5.96 | 36.62 | 3.30 | 45.41 | 8.71 | 1759 |
| **Clover hay** | 91.20 | 12.00 | 30.00 | 2.10 | 47.10 | 8.80 | 1780 |

CBP: Citronella by product

***Growth performance***

Effect of different treatments on growth performance of APRI rabbits is shown in Table 3. It is worthy to note that group fed diet containing 40% CBP+E recorded significantly the highest final body weight with a 5.8% increment comparing to control group. While, group of 20% CBP recorded the worst value. The same trend was observed in daily weight gain. This improvement of final body weight and daily weight gain in 40% citronella by product with or without enzyme may be attributed to the growth promoter as reported by Shah *et al.* (2011) and antimicrobial activity of the effect of residual essential oil such as citral α, citral β, nerolgeraniol, citronellal, terpinolene, geranylmethylheptenone and flavonoids (Lewis, 1986) which has increased when level of citronella by product increased in the diet. These results agree with Podhorsky *et al*. (1984) who found that addition of citronellyl seneciate to bull calves, heifers, pigs and broilers diets increased growth rates and improved nutrient utilization. Rumokoy *et al.* (2017) concluded that supplementing *Cymbopogonnardus* up to 0.5% to broilers ration had a positive effect in feed intake and live body gain.Feed intake was significantly decreased with 40%citronella by product with or without enzyme compared to other groups. It was clear that rabbits fed the high levels of CBP consumed lower amount of feed than those fed the low level and control. This may be due to strongly odour of that aromatic plant. In this respect, Salama (2005) found that feed intake was significantly decreased with rabbits fed 9% geranium by product compared to control.

Regarding to feed conversion ratio (FCR), groups fed 40% CBP either with or without E supplementation recorded significantly the best FCR comparing to other groups. In this connection, Mmereole (2010) and Mukhtar*et al.* (2012) concluded that *Cymbopogoncitrates* could be used as an alternative to antibiotics. It considered as a practical choice to antibiotics for broilers and acts as growth promoting substance in the poultry, and that

**Table 3.** Dietary inclusion of citronella by-product on growth performance of growing rabbits.

| Items | Control | 20% CBP | 40% CBP | 20% CBP+E | 40% CBP+ E | SEM |
|---|---|---|---|---|---|---|
| Initial body weight (g) | 703 | 701 | 705 | 700 | 704 | 6.43 |
| Final body weight (g) | 1714[b] | 1638[c] | 1718[b] | 1676[b] | 1849 [a] | 20.54 |
| Daily weight gain (g) | 18.05[b] | 16.73[c] | 18.08[b] | 17.43 [bc] | 20.45 [a] | 0.36 |
| Daily feed intake (g) | 83.87[a] | 79.37[ab] | 72.50[c] | 81.87[a] | 75.00[bc] | 1.26 |
| Feed conversion ratio (g feed/g gain) | 4.64[a] | 4.74[a] | 4.00[b] | 4.69[a] | 3.66[b] | 0.10 |

a , b and c Means in the same row with different superscripts are significantly different ($P \leq 0.05$).

CBP: Citronella by product, CBP+E : Citronella by product+ Enzyme mixture

resulted minimized feed expense in the production chain. These improvement in growth performance with 40% CBP+ E may be due to enzyme supplementation mixture could support the endogenous enzymes of the poultry & rabbits (amylase and protease), break down some components of cell wall, which cannot be broken down into absorbable nutrients by endogenous enzymes (Tawfeek, 1996), lowering the gastrointestinal viscosity in digestive tract (Simon, 2000), reduced nutrient entrapment and releasing other nutrients like minerals (Al-Harthi *et al.,* 2009, Soliman *et al.,* 2009 and Ibrahim *et al.,* 2010).This reflects on the rabbit's growth performance (Gharaei *et al.,* 2012).

***Nutrients digestibility coefficients***

Results in Table 4 show that all nutrients digestibility coefficient and feeding values were significantly affected by different treatments except dry and organic matter digestibility coefficients. Regarding to crude protein, crude fiber and NFE, groups fed 20% CBP either without or with E recorded the worst values compared to control and 40%CBP diets. The reduction in digestion coefficients of 20% citronella by-product enriched diet without enzyme mix supplementation could be attributed to the high level of non-starch polysaccharides (NSPs) like cellulose and pentosans (arabinoxlans and glucans) as reported by Mohamed (2003). Ether extract digestibility coefficient was significantly decreased in 20% CBP compared to other treatments.. Regarding to feeding values of the experimental diets, digestible CP, total digestible nutrients and calculated digestible energy of the diets, all were significantly decreased in 20% CBP either with or without E. In this respect, El- Manylawi and El-Banna (2013) reported that replacing clover hay with either 10% or 20% date stone meal + Allzyme® SSF to the rabbits diets

**Table4.** Dietary inclusion of citronella by-product on nutrients digestibility coefficients and feeding values of growing rabbits.

| Items | Control | 20% CBP | 40% CBP | 20% CBP +E | 40% CBP +E | SEM |
|---|---|---|---|---|---|---|
| Digestibility coefficients (%) | | | | | | |
| Dry matter (DM) | 65.13 | 61.21 | 64.51 | 64.43 | 65.51 | 2.03 |
| Organic matter (OM) | 63.40 | 59.44 | 63.31 | 61.10 | 65.77 | 2.23 |
| Crude protein (CP) | 76.34$^{a}$ | 68.72$^{c}$ | 74.49$^{ab}$ | 70.76$^{bc}$ | 77.10$^{a}$ | 1.08 |
| Crude fiber (CF) | 40.0$^{ab}$ | 30.33$^{c}$ | 37.45$^{b}$ | 32.12$^{c}$ | 43.66$^{a}$ | 1.47 |
| Ether extract (EE) | 83.41 $^{a}$ | 78.68$^{b}$ | 82.70$^{ab}$ | 82.21$^{ab}$ | 85.30$^{a}$ | 0.87 |
| Nitrogen free extract (NFE) | 77.21$^{a}$ | 69.21$^{c}$ | 75.32$^{ab}$ | 72.43$^{bc}$ | 78.21$^{a}$ | 0.96 |
| Feeding values | | | | | | |
| Digestible crude protein (%) | 13.39$^{a}$ | 12.04$^{b}$ | 12.97$^{a}$ | 12.40$^{b}$ | 13.43$^{a}$ | 0.15 |
| Total digestible nutrients (%) | 59.01$^{ab}$ | 54.43$^{c}$ | 58.76$^{b}$ | 56.31$^{bc}$ | 61.12$^{a}$ | 0.75 |
| Digestible energy (kcal/kg) | 2614.14$^{b}$ | 2411.2$^{c}$ | 2603$^{b}$ | 2494.5$^{c}$ | 2707.6$^{a}$ | 29.01 |

a, b and c Means in the same row with different superscripts are significantly different ($P \leq 0.05$).
*DE = TDN X 44.3 (Schneider and Flatt, 1975).
CBP: Citronella by product , CBP+E : Citronella by product+ Enzyme mixture

resulted in numerical increases in the digestibilities of most nutrients compared to the other tested diets included the control. Also, Salama *et al.* (2019 ) noted that control group recorded higher digestibility coefficient of CP, CF, EE and NFE without significant differences to groups of either 20or 40% fennel seed meal + enzyme mix.In current study, improving digestion coefficient and nutritive values for groups fed diets supplied with enzyme mix could be due to supporting the growth of beneficial bacteria in the gut (Kholif *et al.*, 2005 and Viveros*et al.*, 1993). Reducing digestive tract viscosity by hydrolyzing part of none starch polysaccharides (Bedford and Classen, 1992). Hence, improving nutrient utilization (Choct*et al.*, 1999).

***Carcass characteristics***

As shown in Table 5 group of 40% CBP with or without E recorded higher carcass% without significant variation to control followed by those fed 20% CBP+E and the lowest value was recorded for group of 20% CBP.
Regarding to dressing %, control, groups of 40% CBP with or without E recorded higher percentage without significant differences to other fed 20% CBP+E and control. While, rabbits fed 20% CBP recorded the lowest dressing %. The rest of carcass measurements (liver, kidney, heart and giblets) were not significantly affected by dietary treatments. In this context, Salama (2005) who found that incorporation of 6 or 9% geranium by product in rabbit diets gave the best values of carcass and dressing percentage. Salama *et al.* (2019) who found that replacement up to 40% fennel meal plus enzyme mix instead of clover hay led to insignificant differences in rabbits carcass and dressing

**Table 5.** Dietary inclusion of citronella by-product on carcass characteristics of growing rabbits.

| Items (%) | Control | 20% CBP | 40% CBP | 20% CBP +E | 40% CBP +E | SEM |
|---|---|---|---|---|---|---|
| Carcass | 53.22$^{ab}$ | 50.30 $^{c}$ | 53.41$^{ab}$ | 52.79 $^{b}$ | 54.65 $^{a}$ | 0.41 |
| Liver | 2.92 | 2.83 | 3.03 | 2.88 | 3.25 | 0.07 |
| Kidney | 0.610 | 0.558 | 0.603 | 0.596 | 0.662 | 0.01 |
| Heart | 0.371 | 0.358 | 0.367 | 0.363 | 0.392 | 0.01 |
| Giblets * | 3.90 | 3.74 | 4.00 | 3.83 | 4.30 | 0.09 |
| Dressing ** | 57.12$^{a}$ | 54.04$^{b}$ | 57.41$^{a}$ | 56.62 $^{ab}$ | 58.95$^{a}$ | 0.49 |

a ,b and c Means in the same row with different superscripts are significantly different (P≤0.05).

*Giblets% = Liver%+Kidney%+ Heart %, ** Dressing % = Carcass% + Giblets%.

CBP: Citronella by product, CBP+E : Citronella by product+ Enzyme mixture

percentages. The enhancement in carcass and dressing percentages due to enzymes mix addition was reported by Ibrahim *et al.* (2010) on growing rabbits and Khidr*et al.* (2005) on turkey chicks.

***Blood measurements***

As shown in Table 6. Rabbits fed different treatments did not show any significant variations in serum total protein, albumin and creatinine between them. concerning serum AST, rabbits fed 20% CBP with or without E and 40% CBP+E recorded significantly higher values than control and 40% CBP. While, rabbits fed 20% CBP+E recorded significantly lower ALT values comparing to all groups except group of 40% CBP.

**Table 6.** Dietary inclusion of citronella by-product on blood constituents of growing rabbits.

| Items | Control | 20% CBP | 40% CBP | 20% CBP +E | 40% CBP +E | SEM |
|---|---|---|---|---|---|---|
| **Total protein ( g/dl)** | 6.40 | 5.74 | 6.53 | 6.63 | 6.33 | 0.25 |
| **Albumin ( g/dl)** | 4.94 | 5.10 | 4.43 | 4.93 | 5.30 | 0.13 |
| **AST(U/L)** | 34.36$^{b}$ | 39.23$^{a}$ | 32.20$^{b}$ | 40.43$^{a}$ | 38.22$^{a}$ | 0.88 |
| **ALT(U/L)** | 55.59$^{a}$ | 53.43$^{a}$ | 46.43$^{bc}$ | 41.83$^{c}$ | 51.20$^{ab}$ | 1.44 |
| **Creatinine (mg/ dl)** | 1.29 | 1.92 | 1.81 | 1.56 | 1.40 | 0.10 |
| **Total cholesterol (mg/ dl)** | 96.14$^{a}$ | 79.18$^{b}$ | 73.80$^{b}$ | 75.83$^{b}$ | 71.85$^{b}$ | 2.55 |

a ,b and c Means in the same row with different superscripts are significantly different (P≤0.05).

CBP: Citronella by product, CBP+E : Citronella by product+ Enzyme mixture

All tested groups recorded significantly lower serum total cholesterol rather than control group. The antioxidant properties in CBP may be responsible for reducing rabbit's blood total cholesterol as documented by Ruberto *et al. (*2000). Salama (2005) found that inclusion of 3, 6 or 9% geranium and spearmint by products in rabbit diets reduced total cholesterol. The same conclusion was observed by Salama *et al.* (2019) who found that rabbits fed diets containing fennel seed meal without or with enzyme mix achieved significantly lower serum total cholesterol than un-treated group.

***Economical evaluation***

Cost of producing one kilogram meat is elaborated in Table 7. all of the tested diets recorded lower feed cost than control especially 40% CBP (17.78 LE) followed by40% CBP+E(18.69 LE) as they reduced meat production cost. The decrease in clear in 40% CBP+E (16.32. LE), followed by 40% CBP (17.56 LE) and 20% CBP (21.41LE) then 20% CBP+E (21.50 LE), as compared to control (21.56 LE). It is noticed that net revenue (LE) for diets, economic efficiency and relative economic efficiency increased with 40% CBP +E followed by 40% CBP. Salama (2005) found that replacement of 6

**Table 7.** Dietary inclusion of citronella by-product on producing 1kg meat of growing rabbits and Economic efficiency.

| **Items** | **Control** | **20% CBP** | **40% CBP** | **20% CBP +E** | **40% CBP +E** |
|---|---|---|---|---|---|
| Price of 1 kg diet | 4.643 | 4.510 | 4.380 | 4.580 | 4.450 |
| Total feed intake (Kg) | 4.696 | 4.444 | 4.060 | 4.585 | 4.200 |
| Total feed cost/rabbit (LE)(B) | 21.80 | 20.04 | 17.78 | 20.99 | 18.69 |
| Total weight gain (Kg) | 1.011 | 0.936 | 1.012 | 0.976 | 1.145 |
| Price of 1 kg meat (LE) | 21.56 | 21.41 | 17.56 | 21.50 | 16.32 |
| Price of 1kg body weight | 45 | 45 | 45 | 45 | 45 |
| Selling price/rabbit (LE) (A) | 45.49 | 42.12 | 45.54 | 43.92 | 51.52 |
| Net revenue(LE)[1] | 23.69 | 22.08 | 27.76 | 22.93 | 32.85 |
| Economic efficiency[2] | 108.66 | 110.17 | 156.13 | 109.24 | 175.76 |
| Relative Econ. Eff.[3] | 100 | 101.38 | 143.68 | 100.53 | 161.75 |

Price to produce 1 kg of meat (LE) = total feed cost (LE)/ total weight gain (kg).

(1) Net revenue = A – B.

(2) Economic efficiency = (A-B/B x 100).

(3) Relative Economic Efficiency= Economic efficiency of treatments other than the control/ Economic efficiency of the control group

CBP: Citronella by product, CBP+E : Citronella by product+ Enzyme mixture

or 9% geranium by products in rabbit diets gave the best economical efficiency. El- Manylawi and El-Banna (2013) who found that supplementing Allzyme® SSF (a commercial enzyme mix) in rabbit diets containing 10% date stone meal recorded better economical efficiency compared to control group. Also, Salama *et al.* (2019) came to the same conclusion with adding Natuzyme fortified (enzyme mix) to 10.8% fennel seed meal of the whole diet gained more economical efficiency than control group (fed diet containing clover hay).

***Conclusively***, inclusion of citronella by-product as a new and cheap ingredient at 40% instead of clover hay added with or without enzyme mixture, resulted in enhancing growth performance, carcass traits, nutrient digestibility coefficients and economic efficiency of growing APRI rabbits.

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## التأثير الغذائى لأستخدام مخلف حشيشة السترونيلا مع أو بدون مخلوط الانزيمات على الاداء الانتاجى للأرانب النامیه.

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تم فى هذه الدراسه تقييم الاداء الانتاجى وصفات الذبيحه ومعاملات الهضم وبعض مقاييس الدم والتقييم الاقتصادى لارانب الابرى النامیه المغذاه على علائق تحتوى على مستويات متدرجه من مخلفات السيترونيلا كاستبدال من دريس البرسيم خلال فترةالنمو والتى استمرت لمدة 8 أسابيع. استخدم عدد 80 أرنب ابرى عمر 6 أسابيع بمتوسط وزن 704 جرام ±6,43 . تم تقسيم الارانب عشوائيا الى 5 مجموعات بكل منها 16 أرنب مقسمه الى 4 مكررات بكل مكررة 4 أرانب. تغذت المجموعه الاولى على عليقة قاعديه (مجموعة المقارنه) وتغذت المجموعتان الثانيه والثالثه على علائق تحتوى على 20% و 40% من مخلف السيترونيلا كاستبدال من دريس البرسيم حيث مثلت 5,86% و 11.72% من اجمالى تركيب العليقة على التوالى. ةتغذت المجموعتان الرابعة والخامسه على نفس العلائق السابقة وبنفس نسب الاستبدال ولكن اضيف اليها مخلوط لبعض الانزيمات بمعدل 0,35 جرام/كجم علف. وقد احتوى 1 جرام من مخلوط الانزيمات على 6000 وحدة انزيم سيليوليز, 11000 وحدة انزيم زيلانيز, 1500 وحدة انزيم فيتيز, 700 وحدة انزيم الفا اميليز, 700 وحدة انزيم بيتا جلوكانيز, 700 وحدة انزيم بروتييز.

**وكانت أهم النتائج المتحصل عليها هى** : حققت المجموعة المغذاه على 40% مخلف السيترونيلا + مخلوط الانزيم أعلى وزن حى نهائى بمعدل 5,8 % زيادة عن مجموعة المقارنه, وأفضل معامل تحويل غذائى حيث ان هذا التحسن

راجع الى زيادة معاملات هضم كلا من البروتين الخام والمستخلص الخالى من الازوت والالياف الخام وكذلك وجد تحسن فى نسب الذبيحة والاجزاء الكليه المأكوله بالاضافة لتحقيق ارخص سعر لكليوجرام من اللحم وأعلى كفاءة أقتصادية.

**التوصية:** يمكن ان نستخلص من هذه الدراسه انه يمكن احلال مخلف السترونيلا بمعدل يصل الى 11.72% + مخلوط الانزيم فى علائق الارانب الناميه والذى ادى الى تحسين الاداء الانتاجى و الكفاءة الاقتصادية