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(RESEARCH ARTICLE)



## Performance, carcasses, cholesterol and beta-carotene of rabbit meat fed with concentrate and carrot (*Daucus carota*) leaves

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### Abstract

This study aims to observe the effect of concentrated levels in carrot leaf based feeds to improve performance, carcass and  $\beta$ -carotene content in local rabbit meat at 8 weeks. This study used a feed experiment using 120 local 8-week-old male rabbits divided four group treatments and 6 replications. The four group treatments were rabbits fed on carrot leaf based rations with supplementation: 0% concentrate as a control (A), 10% (B); 20% (C); and 30% (D), respectively. Each treatment consisted of six replication cages with five rabbits per cage. The results showed that feed consumption, final body weight, weight gain, carcass weight, and percentage of carcasses in Groups B, C and D, were significantly ( $P < 0.05$ ) higher than Group A. The lowest cholesterol content was found in rabbits group A ( $P < 0.05$ ). In contrast, the highest beta-carotene levels of meat ( $P < 0.05$ ) were found in group A. It was concluded that supplementation of 10-20% concentrate in carrot leaf based rations could increase live weight gains, carcass weight, carcass percentage, and feed efficiency in local rabbits up to 8 weeks old. The highest content of  $\beta$ -carotene in rabbit meat was found in feeding 100% of carrot leaves.

**Keywords:** *Daucus carota*; Cholesterol;  $\beta$ -carotene; Rabbit

### 1. Introduction

Improving the performance of rabbits is an alternative that can be used as a source of high-quality animal protein, and diversification of animal protein sources, but white rabbit meat, less favored by consumers. The advantage of rabbits as a producer of meat, namely the quality of meat, where high protein content with low fat content, and better than other livestock meat, such as beef and pork. The protein content of rabbit meat is 20.10%, while cattle and pigs are: 16.3% and 11.9%. The fat content of rabbit meat is 10.2%, while cattle and pigs are: 28% and 45% [1]. Rabbits are one of the alternative livestock that have great potential to be bred to meet the needs of animal protein in the Indonesian people as well as to increase the welfare of farmers.

In intensive rabbit breeding patterns, the largest production cost comes from feed, which is around 60-70%. Therefore, the breeder must do it with efforts to increase feed efficiency. Rabbit livestock business is the choice to be cultivated, because the feed does not compete with human needs. Giving high forage to rabbits can improve feed efficiency. Rabbits can be raised by providing forage food combined with agricultural waste [2]. One of agricultural waste that can be utilized is carrot leaf (*Daucus carota*). Carrot leaves contain crude protein 18.71%; crude fiber 15.69%; crude fat 3.19%; and ash 33.58% [3]. The data shows that carrot leaves have higher protein content and low crude fiber, so that carrot leaves can be a good alternative feed as rabbit feed. However, the metabolic energy content is low and has not been able to meet the needs of rabbits for the production process [4]. Therefore, it needs to be supplemented with concentrate feed so that rabbit productivity can be optimal.

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Bioconversion of  $\beta$ -carotene by its cleavage enzyme has been widely studied. An interesting recent study has shown that the expression and activity of major cleavage enzymes in the intestine are regulated by the feed consumed and genetics [5].

The higher the level of concentrate in grass-based rations, causing an increase in digestible energy, metabolic energy, and energy that is retained in the body of rabbits [6]. Likewise, the protein that is retained in the body of the rabbit is increasing. The local rabbit fed basal native grasses with supplementation of concentrate produce carcass weight and retention of energy and protein in the body was rather than unsupplemented [1]. The nutritional needs of local rabbits in the tropics are: 16% protein with 2600 kcal/kg of metabolic energy [7]. To get optimal rabbit growth, it is necessary to supplement with concentrate [6].

Carrots (*Daucus carota* L.) is a type of vegetable that is well known as a source of provitamin-A (carotenoids). The carotenoid content is very high and much higher than tomatoes. In addition to the high carotenoid content, carrot production in Indonesia is quite abundant. Carrot production in Indonesia reached 350,170 tons and leaf waste produced very much as a competitive alternative animal feed. The  $\beta$ -carotene compound as an active carcass color agent, so it is very important for its role in increasing the color of white rabbit carcass to red which is very preferred by consumers [8]. Carrot leaves contain high phytochemical compounds, such as flavonoids, phenolics, terpenoids, steroids, tannins, carotenoids and high beta carotene [9].

It is interesting to study its usefulness as a natural feed supplement is carrot leaf because it is a waste of carrot harvesting. Based on this, researchers are interested in examining the effect of concentrate levels in carrot leaf-based rations to improve performance, carcass, and  $\beta$ -carotene content in rabbit meat.

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## 2. Material and methods

### 2.1. Animals and experimental design

This study used 120 healthy male local rabbits aged 56 days with homogeneous body weight ( $651.82 \pm 11.06$  g). This study used a Carrot leaf based rations with supplementation: 0% concentrate as a control (A), 10% (B); 20% (C); and 30% (D), respectively. Each group treatments in six replication with five rabbits per cages. The size of each cages was:  $100 \times 50 \times 40$  cm<sup>3</sup> (length x width x height). Concentrated feed was pellet form and rabbits had free access to feed and drinking water during the experiment period. Body weight and feed intake are registered every days. The observed variables were: feed consumption, weight gain, feed efficiency, carcass, carcass percentage, protein content and  $\beta$ -carotene content in rabbit meat.

### 2.2. Live performance.

Body weight, live weight gains (LWGs), feed intake and feed conversion ratio for rabbits were recorded separately every days. Feed consumption (grams per rabbit) was recorded every days on each replication. Total feed intake for each test was measured during the trial period. Feed Conversion Ratio (FCR) was calculated as grams of feed consumed per gram of body weight obtained. FCR is an indicator to measure feed efficiency. The lower the FCR value, the higher the feed efficiency. The ingredients of the experimental diet and chemical composition are shown in Table 1.

### 2.3. Slaughter procedures

At the end of the study, all rabbits were slaughtered to obtain carcass weight and carcass percentage. Carcass weight was obtained by slaughtered rabbits by cutting the jugularis vein in the neck to remove blood from the rabbit's body [10]. The percentage of carcasses was calculated as the weight of fresh carcass divided by body weight of the rabbit before being slaughtered, multiplied by 100% [11]. Slaughtered rabbits were then skinned, then the internal organs and digestive tract are removed. Head weight, thymus, trachea, esophagus, heart, lungs, liver and kidneys were removed from the weight of slaughtering, to obtain carcass weight. The percentage of carcasses was the ratio between carcass weight and rabbit weight before slaughter.

**Table 1** Ingredients and nutrient composition content of the feed of growing rabbits aged 8-16 weeks

Ingredients	Composition (%)	ME (Kcal/kg)	Crude Protein (%)	Ether Extract (%)	Crude Fibre (%)	Ca (%)	P (%)
Fish meal	2.0	59.4	0.8	0.18	0.02	0.154	0.078
Pollard	35.10	456.3	5.27	1.40	3.51	0.05	0.116
Yellow corn	49.0	1651.3	7.35	1.91	0.98	0.01	0.049
Coconut meal	7.0	107.8	1.47	0.13	1.05	0.01	0.014
Pignox*	6.4	125.4	0.19	0.01	0	0.06	0.001
NaCl	0.3	-	-	-	-	-	-
Total	100	2400.24	15.08	3.63	5.56	0.28	0.26

\*) The composition "Pignox" in every gram contains: 40 mg Olaquinox; 800 IU Vitamin D3; 5000 IU of vitamin A; 2 mg of vitamin E; 0.4 mg of vitamin B1; 0.8 mg of vitamin K3; 0.4 mg of vitamin B6; 0.8 mg of vitamin B2; 8 ug of vitamin B12; 8 mg of nicotinic acid; 6 mg Ca-D-pantothenate; 200 mg of cholin chloride; 40 mg of methionin; 8 mg Mn; 0.4 mg I; 16 mg Fe; 0.2 mg Co; 20 mg Cu; and 20 mg Zn (Medion, Bandung-Indonesia; Kementan RI No.D 06121109FTS.2); \*\*)according to [12].

#### 2.4. Measurement of cholesterol levels in meat

Observation of meat cholesterol levels was done once, namely in the last week of the study using carcass meat taken in each unit of the experiment. Cholesterol analysis using the Lieberman-Burchad method from [13]. The sterol solution in chloroform was witnessed with acetic acid anhydrous concentrated sulfuric acid. In later tests the color was from bluish green to green, depending on the cholesterol level of the sample. The resulting solution was listed on the spectrophotometer to obtain optical density (DO). The results were then compared with DO from standard solutions, so that the amount of cholesterol in the sample can be calculated.

#### 2.5. Statistical analysis

All of data were analyzed with one-way variance and if there was a significantly difference ( $P < 0.05$ ) between treatments, it was followed by Duncan's multiple range test.

### 3. Results

Table 2 showed that administration of concentrate at the level of 10-30% in carrot leaf based ration, statistically showed a significantly difference ( $P < 0.05$ ) in final body weight, live weight gains, feed consumption, feed conversion ratio (FCR), slaughtered weight, carcass weight, carcass percentage, and beta-carotene content in rabbit meat. Cholesterol content in rabbit meat was significantly difference ( $P < 0.05$ ) between treatments. More details are presented in Table 2.

#### 3.1. Growth Performance and Carcasses

The final body weight of rabbits fed with carrot leaves without supplementation concentrate (A) was 1560.05 g/head (Table 2). The final average body weight of rabbits showed a significant increase ( $P < 0.05$ ) with the supplementation of 10% concentrate (B), 20% concentrate (C), and 30% concentrate (D), which was: 8.31%; 12.55%; and 15.11% higher than controls. Likewise, the weight gain of rabbits treated B, C, and D experienced a significant increase ( $P < 0.05$ ), namely: 14.31%; 21.02%; and 25.67% higher than the control (A). Supplementation of concentrates in Carrot leaf based ration significantly ( $P < 0.05$ ) increased feed consumption (carrot leaves and concentrates). Feed intake in rabbits Group B, C and D, were: 7.69%; 13.09%; and 12.69% were significantly ( $P < 0.05$ ) higher than controls, but between treatments B, C and D did not show any significant difference ( $P > 0.05$ ). More details are presented in Table 2.

Feed Conversion Ratio (FCR) is a comparison between feed consumption and live weight gains in the same time unit. The average FCR in control rabbits was: 3.95/head (Table 2). Concentrated supplementation in Group B, C, and D of rabbits significantly different ( $P < 0.05$ ) can improve feed efficiency: 5.82%; 6.58%; and 10.38% higher than controls.

**Table 2** Carcass and performance of rabbits (8-16 weeks old) fed concentrate on carrot (*Daucus carota*) leaf-based ration.

Variabel	Treatment Group <sup>1)</sup>				SEM <sup>2)</sup>
	A	B	C	D	
Initial body weight (g/head)	650.37a	649.83a	654.91a	652.57a	10.681
Final body weight (g/head)	1560.05b	1689.73a	1755.82a	1795.81a	38.186
Body weight gains (g/head/56 days)	909.68b <sup>3)</sup>	1039.90a	1100.91a	1143.24a	40.062
Live weight gains (g/head/days)	16.24b	18.57a	19.66a	20.42a	0.629
Feed consumption (g/head/days)	64.15b	69.08a	72.55a	72.29a	2.307
FCR (feed consumption:LWGs)	3.95b	3.72a	3.69a	3.54a	0.069
Slaughtered weight (g/head)	1548.59b	1686.62a	1750.35a	1790.06a	41.704
Carcass weight (g/head)	728.30b	838.92a	876.58a	902.37a	30.513
Carcass percentage (%)	47.03b	49.74a	50.08a	50.41a	0.618
Meat cholesterol (mg/100g)	158.52b	161.06b	168.73a	170.39a	1.815
Beta-carotene in meat (µ/g)	62.94a	60.72a	49.27b	44.51b	2.394

Note: Level of concentrate in carrot leaf based rations, is: 0% (A); 10% (B); 20% (C); and 30% (D), respectively. SEM: standard error of treatment means. Means with different superscripts within raw values are significantly different ( $P < 0.05$ ).

Supplementation of concentrates in carrot leaf based ration significantly ( $P < 0.05$ ) increased slaughtered weight (Table 2). The average slaughtered weight in rabbits group B, C, and D, were: 78.91%; 13.03%; 15.59% was significantly ( $P < 0.05$ ) higher than the control, but between treatments B, C and D did not show any significant difference ( $P > 0.05$ ). Carcass weight and percentage of carcasses of rabbits which were given carrot leaves without concentrate supplementation as a control, were: 728.30 g/head and 47.03% (Table 2). Average carcass weight in rabbits group B, C, and D, were: 15.19%; 20.36%; and 23.90% significantly ( $P < 0.05$ ) higher than controls. Likewise, the average percentage of carcasses in rabbits treated B, C, and D, were: 5.76%; 6.49%; and 7.19% were significantly ( $P < 0.05$ ) higher than controls.

### 3.2. Cholesterol and $\beta$ -carotene

The lowest cholesterol level in rabbit meat was found in the administration of 90-100% Carrot leaves (groups C0 and C1), and showed significant differences ( $P < 0.05$ ) compared to the treatment groups C2 and C3. Cholesterol levels in rabbit meat in groups C2 and C3 were: 21.72% and 29.28% significant ( $P < 0.05$ ) higher than group C0. More details are presented in Table 2. The beta-carotene content in rabbit meat decreased significantly ( $P < 0.05$ ) with the addition of concentrate in the ration (Table 2). The  $\beta$ -carotene content in rabbit meat in treatment B was 3.53% lower ( $P > 0.05$ ) rather than treatment A. Supplementation of 20% concentrate (treatment C) and 30% concentrate (treatment D) significantly ( $P < 0.05$ ), reduced  $\beta$ -carotene content in rabbit meat, namely: 21.72% and 29.28% lower compared to controls.

## 4. Discussion

### 4.1. Growth Performance and Carcasses

Supplementation of concentrates in carrot leaf based rations significantly improved the growth performance of rabbits. Concentrate is a mixture of several types of quality feed, so that the high protein content is above 21% and crude fiber is lower than 18%, and the dry matter digestibility is above 75%. To improve the performance of rabbits, feeding must be regulated, so that the balance between forage and concentrate can meet the nutrient requirements for rabbit production [14]. Concentrated supplementation combined with carrot leaf herbs will improve morphology of the small intestine by different mechanisms [15]. Carrot leaves contain phytochemical compounds, such as flavonoids and beta carotene which are quite high [9]. Flavonoids and beta carotene can inhibit pathogenic microbes and endotoxins in the gastro intestinal tract and increased activity of the pancreas in broiler [16, 17]. Some studies have found that foraging as much as 60-80%, while concentrates as much as 20-40% of the total amount of feed given, can give the best results. The highest performance of rabbits was in giving rations with 16% protein and 2800 kcal/kg metabolizable

energy compared to 2200 kcal/kg; 2500 kcal/kg and 3100 kcal/kg metabolizable energy [9]. The rabbits fed with higher protein diets produced higher performance compared to low protein diets [9]. Protein, carbohydrates, fats, minerals, vitamins, and water are nutrients that are needed by rabbits [18, 2].

Feed conversion ratio (FCR) value is the ratio between feed consumption and live weight gains in the same time unit. It is an indicator to assess the level of feed efficiency. The lower FCR value means higher feed efficiency. The level factor of carrot leaf forage with concentrate affects feed consumption, growth and feed efficiency. Contrary to the results of research, that the forage-concentrate balance in the ration, and the ration giving factor, apparently had no effect on rabbit weight gain [19]. The content of crude fiber in feed can also affect feed efficiency. The use of high-fiber food in rabbit ration in general, is not recommended because of the negative effects given to nutritional utilization and performance, such as decreased digestibility of feed and decreased weight gain as well as decreased feed efficiency [9]. Some types of crude fiber feed have the effect of increasing the activity of the gizzard function, resulting in increased reflux of the digestive tract and digestive enzymes in poultry [20].

The carcass weight and percentage of the carcass of the rabbit increases with a concentrate of 10-30% in its ration. This increase is due to the concentration of food with high protein and energy content, and has a high digestibility, so it can meet the needs for optimal rabbit growth [21]. The administration of concentrate in rabbits can stimulate the growth of rabbits with high carcass weight [4]. It was also reported that the weight and percentage of carcasses of rabbits were lowest when given grass or carrot leaves without supplementation of the concentrate.

#### 4.2. Cholesterol and $\beta$ -carotene

The higher the supplementation of the concentrate, causing decreased consumption of carrot leaves. This happens because the concentrate is given first, followed by then carrot leaves. Rabbits will stop consuming rations when their energy needs are fulfilled. Carrot leaves contain phytochemical compounds, such as flavonoids, saponins, and tannins. Flavonoids, similar to estrogen which can reduce yolk cholesterol, and increase high density lipoprotein levels in meat of broiler [22, 23]. Phytochemical compounds from herbal leaves (*Curcuma longa*) in diets can reduce the cholesterol content of rabbit meat [24]. Xanthophil compounds, such as lutein, zeaxanthin, meso-zeaxanthin, astaxanthin, and canthaxanthin are carotene oxygen derivatives [25]. In addition, lower levels of meat cholesterol in treatments A and B can be caused by the high content of crude fiber in carrot leaves, which plays an important role in binding and eliminating cholesterol [26, 27, 28]. The increase levels of crude fiber in feed can reduce feed consumption, percentage of abdominal fat, and LDL-blood cholesterol, but do not affect final body weight [29].

Color is an important quality of food, because it influences perceptions of the quality and intensity of tastes and tastes of consumers, and purchasing decisions [30]. The color of rabbit meat is white, so it is less liked by consumers [17]. Color greatly affects the acceptability of consumers, because it is identical with quality. The color of meat is influenced by feed, stress, pH, and oxygen [25]. The color of the meat measured consists of three parameters, namely: brightness, redness, and yellowish. Meat color is a combination of several factors and the intensity of each color has characteristics, namely the color pattern and color intensity. The color favored by consumers is the bright red flesh color. The appearance of a bright red color in meat is caused by the presence of oxygen bonds in the Ferro ion ( $Fe^{2+}$ ) in the molecular structure of myoglobin [31].

The color of rabbit meat seen from its beta-carotene content turns out to be redder with carrot leaves compared with the concentrate. This increase is due to the higher  $\beta$ -carotene content in carrot leaves than the concentrate. Increasing the amount of concentrate given to rabbits will automatically reduce consumption of carrot leaves, thereby affecting the  $\beta$ -carotene content in rabbit meat. The color of rabbit meat given carrot leaves (Group A) has a much higher yellow color than treatments C and D. The increase in the beta-carotene content of meat is strongly related to the ingredients used in the ration. Carrot leaves contain high phytochemical compounds, such as flavonoids, phenolics, terpenoids, steroids, tannins, carotenoids and high beta carotene [4]. Specifically, lutein compounds are active yellow dyes. The increase supplementation of herbal leaves in the ration resulted in a linear increase in egg yolk color [32, 22]. The local rabbits fed supplemental herbal leaves could increase the intensity of the color of rabbit meat compared without the addition of herbal leaf flour [33]. Conflicting results, that an increase in the content of beta-carotene (flavonoids) in the diet apparently had no effect on increasing the color of the meat [34, 35].

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## 5. Conclusion

It was concluded that supplementation of 10-20% concentrate in Carrot leaf based rations could increase weight gain, carcass weight, carcass percentage, and feed efficiency in local rabbits aged 8-16 weeks. Beta-carotene content in rabbit meat has increased with the addition of Carrot leaves, but decreased meat cholesterol content.

## Compliance with ethical standards

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### *Disclosure of conflict of interest*

All authors have read and agreed to send this manuscript to GSC Biological and Pharmaceutical Sciences. The authors state that this research was carried out in the absence of commercial or financial relationships that could create a conflict of interest.

### *Statement of ethical approval*

All procedures performed in experiments involving experimental animals were in accordance with the Use of Laboratory Animals at the Faculty of

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