ISSN 1819-1878

Asian Journal of Animal Sciences

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OPEN ACCESS Asian Journal of Animal Sciences

ISSN 1819-1878
DOI: 10.3923/ajas.2016.255.261

Research Article

Effects of Feeding Diets Containing of Some Aromatic and Medicinal Plants Remnants on Meat Quality, Fatty and Amino Acids Fractions of New Zealand White Rabbits

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Abstract

Background: One hundred and eight weaned NZW rabbits used to investigate the effect of using remnants of mint, fennel, basil and anise with or without probiotic to replace 50% from alfalfa hay in rabbit's diets. This part of study had shown the effects of experimental diets on rabbit meat composition and its fatty and amino acids. **Materials and Methods:** The four remnants were obtained after oil extraction and were incorporated in rabbit diets, rabbits randomly assigned in to 9 experimental groups, the experimental period lasted for 8 weeks. Chemical composition, fatty and amino acids were analyzed. **Results:** Chemical composition of meat fed different experimental diets were in the normal structure in rabbit meat with slight differences among them. Data of fatty acids fractions observed that Poly Unsaturated Fatty Acids (PUFA) were the highest proportion of total fatty acid (41.90%) after that the percent of Saturated Fatty Acids (SFA) (40.39%) then the percent of Mono Unsaturated Fatty Acids (MUFA) (17.71%). The highest value of the total non-essential amino acids was found in anise and anise with probiotic treatment (67.65 and 67.49 g/100 g) treatment, whereas, the lowest value was found in control, fennel and fennel with probiotics (62.73, 62.13 and 62.13 g/100 g, respectively) treatment. **Conclusion:** Summing up, using of that medicinal plants remnant to replace 50% from alfalfa hay in rabbit diets did not have any adverse effects on chemical composition of rabbit meat and its fractions of fatty and amino acids.

Key words: Rabbit, mint, fennel, basil, anise, fatty acids, amino acids

Received: April 27, 2016 Accepted: July 09, 2016 Published: August 15, 2016

Citation: Hemat S. Mohamed, Adel E.M. Mahmoud, Mohamed S. Abbas and Hassan M. Sobhy, 2016. Effects of feeding diets containing of some aromatic and medicinal plants remnants on meat quality, fatty and amino acids fractions of New Zealand white rabbits. Asian J. Anim. Sci., 10: 255-261.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Rabbits are small mammals, as herbivore animals can be nourished with straw, forages, by-products and domestic waste and those that are not in competition to human food[1]. Their meat is very nutritious, simply digestible and extremely low in cholesterol and sodium levels and high levels of protein with essential amino acids. So, rabbit's meat considered a functional food and bioactive compounds in meat could be manipulated by manipulation of rabbit diet to increase levels of PUFA, Conjugated Linolinc Acid (CLA), vitamin E and selenium[2].

Consequently, aromatic plants and their extracts have the potential to become new generation substances for human and animal nutrition and health[3].

Nutrition has significant effects on cost of production and the end product quality in livestock animal production. So, livestock nutritionists search every time to reduce production cost and keeping on the product quality. Alfalfa hay represent around 30-35% from formula of rabbit. Many studies tried to find an alternative source to replace it. From these alternative sources are by-products of medicinal plants like mint, fennel, basil and anise. These herbs produced by huge amount in Egypt because it's used in medicinal treatments[4,5]. The diet enriched with the plant extracts is beneficial for the health state of rabbits involving the nutritional quality of rabbit meat in connection with consumers[6].

High fat intakes change rabbit carcass composition towards a higher protein content and therefore higher water content so that carcass body weight becomes increased. However, this study showed a clear effect of the type of fat on growth performance and has demonstrated that increasing fat intakes enhanced weight gain and improved the effectiveness of feed[7].

Fatty acids play a key role in metabolism: As a metabolic fuel. Fatty acids represent 30-35% of whole energy intake in many manufacturing countries. Moreover, poly-unsaturated fatty acids in people foods have been shown to have health benefits. Therefore, they investigated the potential to incorporate them into rabbit meat by adding them to the diet[8]. The quality of crossbred rabbit meat was higher because it contained fewer fats and the quality of protein and intramuscular fat was higher too[9].

Probiotic play a vital role to increase youngs productivity and safety within breeding, that has a positive impact on rabbits' health, reproduction and digestion efficiency[5]. Probiotic supplementation to diets has significant effect on growth performance and has a positive effect on the relative revenue[10].

Rising prices of feed (alfalfa hay) that used in feeding the rabbits leads to increase cost of raising rabbits. The existence of problems in rabbits and suffering certain diseases, which lead to they died.

Therefore, this study aimed to determine the effect of using medicinal and aromatic plants remnants to replace 50% from alfalfa hay on rabbit meat quality, fatty and amino acids fractions.

MATERIALS AND METHODS

Plants and diets: The four remnants (mint, fennel, basil and anise) were obtained after oil extraction and were incorporated in rabbit diets at level 17.5% without probiotic and with probiotic (replacement 50% of alfalfa hay), chemical composition of the experimental diets shown in Table 1.

Table 1: Chemical composition and fiber fractions content of the experimental diets

		Experimental diets							
		Mint		Fennel		Basil		Anise	
Item (%)	Control	Mint	Mint+probiotic	Fennel	Fennel+probiotic	Basil	Basil+probiotic	Anise	Anise+probiotic
Chemical composition									
DM	90.76	90.70	90.18	90.39	89.31	90.78	88.78	90.41	88.66
OM	91.98	91.60	92.31	91.73	91.40	91.64	92.43	92.13	91.82
Ash	8.02	8.40	7.69	8.27	8.60	8.36	7.57	7.87	8.18
CP	17.36	16.39	16.44	16.61	16.44	16.89	17.08	16.95	17.13
EE	2.40	2.25	2.50	2.40	2.47	2.26	2.39	2.53	3.80
CF	13.62	14.17	12.44	11.88	12.23	13.85	13.91	12.54	11.87
NFE	58.60	58.79	60.93	60.61	60.26	58.64	59.05	60.11	59.02
Fiber fractions									
NDF	24.87	27.53	26.39	27.53	20.57	27.34	25.64	23.76	22.47
ADF	14.45	17.46	14.28	17.46	10.80	16.37	14.49	13.50	12.85
ADL	4.04	7.40	1.66	7.40	1.03	5.39	3.34	3.25	3.23
Cellulose	10.41	10.06	12.62	10.06	9.77	10.98	11.15	10.25	9.62
Hemi cellulose	10.93	12.73	11.65	12.73	9.53	10.82	12.07	10.22	10.44

DM: Dry matter, OM: Organic matter, CP: Crude protein, EE: Ether extract, CF: Crude fiber, NFE: Nitrogen free extract, NDF: Neutral detergent fiber, ADF: Acid detergent fiber and ADL: Acid detergent lignin

Animals and management: A total number of 108 weaned New Zealand white rabbits (5 weeks of age and about 635±5 g average of body weight) were used. They were individually weighed to the nearest g and randomly assigned in to 9 experimental groups. Each group was divided into 4 replicates of 3 rabbits each. The experimental period lasted for 8 weeks. Body weight gain and feed intake were weekly recorded and then feed conversion ratio was calculated.

Proximate analysis of rabbit meat: Three rabbits from each treatment were taken for analysis of meat. Samples of meat dried at 60°C for 2 days, freed from any bones and ground for analysis. Samples of meat were chemically analyzed for the determination of each of CP, EE and ash contents according to the method of AOAC[11].

Fatty acids determination: Weight (2 g) of the sample into a 250 mL centrifuge bottle, add sufficient water to bring total water present to 16 mL together with 40 mL methanol and 20 mL chloroform. Macerate for 2 min, add further 20 mL chloroform and macerate for 30 sec, add 20 mL water and macerate again for 30 sec. Centrifuge the mixture for 10 min at 2000-2500 rpm. Draw off the lower chloroform layer and filter through a coarse filter paper in to a dry weighed flask or beaker. Evaporate the chloroform to dryness[12]. After that, in a tube weigh 50 mg of lipid, add 5 mL of methanol sulphuric acid (1 mL conc. sulphuric acid and 100 mL methanol) and 2 mL of benzene, close the tube well and place in water bath at 90°C for an hour and half. Cool, add 8 mL water and 5 mL petroleum ether shake strongly and separate out the ethereal layer in a dry tube. Evaporate to dryness[13].

Amino acids composition: Performic acid oxidation is performed prior to hydrolysis to oxidize cysteine and methionine to cysteine acid and methionine sulfone, respectively. Sodium metabisulfite is added to decompose performic acid. Amino acids are liberated from protein by hydrolysis with HCL. Hydrolysates are diluted with sodium citrate buffer or neutralized, pH is adjusted to 2.20 and individual amino acid components are separated on ion-exchange chromatograph. Tryptophan is destroyed by hydrolysis, so these amino acids cannot determine[14].

Statistical analysis: Statistical analysis were carried out using F-test for significance at $p \leq 0.05$ and computing of Least Significant Difference (LSD) test, values to separate means in different statistical groups according to described method by Little and Hills[15].

RESULTS AND DISCUSSION

Effect of remnant medicinal plants on chemical composition of meat: Results of chemical analysis of meat shown in Table 2 cleared the lowest moisture content (69.10%) was recorded with rabbit fed basil and the highest value (74.83%) was found in mint rabbit meat. While, the lowest ash content was found in fennel (0.90%) and the highest was found in basil (1.04%). On the other hand, the lowest content of protein was found in fennel (16.82%) and the highest was found in control (19.61%). When, the lowest total lipid was found in mint (5.71%) and the highest was found in basil (10.55%). Generally, data of proximate analysis of meat did not appear any adverse effect of tested diets compared with control diet. Gondret *et al.*[16] and Simonova *et al.*[6] showed that the chemical composition of meat is closely related to age; e.g., water content decreases with increasing age. Whereas, some of reports demonstrated a decrease the protein content[6] or an increase the protein content[16,6] with increasing age. While, many authors presented the lipid content of rabbits meat in the range from 0.6-14.4 indicated that the contents of lipids determined were below the average[6,17]. These results may be due to the similarity in chemical composition of the experimental diets that provided same requirements of all nutrients. The quality of rabbit meat in all treatment was

Table 2: Chemical composition of meat

Treatments	Moisture	Ash (%)	Protein	Total lipid
Control	71.92±0.89[abc]	0.95±0.13[a]	19.61±0.27[a]	7.52±0.49[bc]
Mint	74.83±1.30[a]	1.03±0.17[a]	18.43±0.70[abc]	5.71±0.63[c]
Mint+probiotics	72.02±0.36[abc]	1.03±0.08[a]	17.52±1.06[bc]	9.43±0.88[ab]
Fennel	74.36±0.63[ab]	0.90±0.00[a]	16.82±0.86[c]	7.92±0.23[abc]
Fennel+probiotics	70.02±0.88[c]	1.02±0.05[a]	18.81±0.47[ab]	10.15±0.36[ab]
Basil	69.10±0.56[c]	1.04±0.01[a]	19.31±0.35[a]	10.55±0.90[a]
Basil+probiotics	69.37±0.68[c]	0.98±0.01[a]	19.33±0.15[a]	10.33±0.84[ab]
Anise	71.60±1.16[bc]	1.00±0.01[a]	19.29±0.20[a]	8.12±1.36[abc]
Anise+probiotics	71.54±1.65[bc]	0.94±0.02[a]	19.25±0.17[ab]	8.28±1.82[abc]
$LSD_{0.05}$	1.44	0.11	0.83	1.42

Treatments that are not significantly different at the 5% level are indicated by the same letters in the same column. Error bars are±SE higher because it contained less fat and the quality of protein was higher, this result was agreement with Dalle Zotte[18] which indicated that the quality of crossbred rabbit meat was higher in contained less fat and the quality protein was higher.

Effect of medicinal plants on fatty acids of rabbit meat: Data indicated that using some of remnants medicinal plants affected on the proportion and diversity of fatty acid in NZ white rabbit meat (Table 3). Results appeared wide variability of Saturated Fatty Acids (SFA) in meat rabbit in the different treatment. Ten saturated fatty acids were found in control and anise treatment and nine fatty acids were found in basil+probiotics and anise+probiotics treatment. While, eight saturated fatty acids were found in mint, mint+probiotics, fennel, fennel+probiotics and basil. Comparing all treatments, the highest proportion of total SFA was found in fennel, anise, control and mint (p = 59.097, 57.09, 55.765 and 54.48), respectively. Whereas, basil+probiotics was the lowest proportion (p = 3.730).

The highest proportion of Mono Unsaturated Fatty Acids (MUFA) was found in fennel, anise+probiotic (p = 37.9). Whereas, control was the lowest proportion (p = 4.00), supporting results finding by Macijauskiene and Ribikauskiene[9] who indicated that the highest proportion of MUFA were found in diet and the lowest was found in control.

There were higher alterations in values of Poly-unsaturated Fatty Acids (PUFA) in rabbit meat among treatment. Linoleic acid (C18:2ω6) was the highest proportion of PUFA and (C18:3ω3) was the lowest proportion of PUFA, in mint, mint+probiotics, fennel, fennel+probiotics basil, basil+probiotics, anise and anise+probiotics.

In this study, it was indicated that the proportion of saturated fatty acids was higher than the proportion of poly-unsaturated fatty acids that was higher than the proportion of mono unsaturated fatty acids and these results were in agreement with Gondret *et al.*[16] results. On the other hand, the most prevalent fatty acids in this study are palmitoleic (C16:1), palmitic (C16:0) and linoleic (C18:2) acids, whereas, Alasnier *et al.*[19], Ramirez *et al.*[20] and Hernandez[21] showed that the most prevalent fatty acids are linoleic (C18:2), palmitic (C16:0) and oleic (C18:1) acids, showing percentages higher than 20% of total fatty acids. Altogether, rabbit meat has a high ratio of PUFA to SAT fatty acids for the loin and the meat of hind leg.

Comparing all treatments, the highest proportion of total PUFA was found in fennel and anise (p = 56.22 and 54.18). Whereas, mint was the lowest proportion (p = 10.66). These result agreed with Macijauskiene and Ribikauskiene[9] which were found that rabbit meat crossbred contained lower content of fatty acids and higher content of poly-unsaturated and total unsaturated fatty acids and these results were disagree with Dal Bosco *et al.*[22] which were indicated that the highest proportion of fatty acid was SFA (41.9% in alfalfa and 41.7% in diets) after that the percent of PUFA

Table 3: Effect of remnant medicinal plants on fatty acids in different treatments

Fatty acids	Control	Mint	Mint+probiotics	Fennel	Fennel+probiotics	Basil	Basil+probiotics	Anise	Anise+probiotics	$LSD_{0.05}$
Saturated fatty acids										
C8:0	0.08 ± 0.01^{a}	0.04 ± 0.01^{bc}	0.00 ± 0.00^{d}	0.05 ± 0.01^{b}	0.05 ± 0.01^{b}	0.03 ± 0.00^{c}	0.05 ± 0.00^{bc}	0.06 ± 0.00^{b}	0.06 ± 0.00^{b}	0.02
C10:0	0.06 ± 0.01^{b}	0.00 ± 0.00^{c}	0.12 ± 0.03^{a}	0.07 ± 0.01^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.09 ± 0.00^{ab}	0.07 ± 0.00^{b}	0.07 ± 0.02^{b}	0.04
C11:0	0.12 ± 0.01^{a}	0.13 ± 0.01^{a}	0.12 ± 0.03^{a}	0.06 ± 0.00^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	0.04 ± 0.00^{b}	0.07 ± 0.01^{b}	0.07 ± 0.00^{b}	0.03
C12:0	0.06 ± 0.01^{bc}	0.08 ± 0.02^{abc}	0.06 ± 0.00^{c}	0.09 ± 0.01^{a}	0.11 ± 0.00^{a}	0.09 ± 0.00^{ab}	0.10 ± 0.00^{a}	0.09 ± 0.01^{ab}	0.10 ± 0.01^{a}	0.03
C13:0	0.28 ± 0.08^{a}	0.14 ± 0.00^{b}	0.12 ± 0.01^{b}	0.14 ± 0.01^{b}	0.17 ± 0.01^{b}	0.15 ± 0.00^{b}	0.12 ± 0.00^{b}	0.14 ± 0.02^{b}	0.14 ± 0.01^{b}	0.08
C14:0	3.13 ± 0.01^{a}	3.11 ± 0.01^{a}	0.00 ± 0.00^{e}	0.00 ± 0.00^{e}	0.67 ± 0.02^{b}	0.34 ± 0.03^{c}	0.17 ± 0.01^{d}	0.21 ± 0.00^{d}	0.20 ± 0.01^{d}	0.04
C16:0	29.82 ± 1.18^{cd}	31.18 ± 0.01^{bc}	24.40 ± 0.24^{d}	49.66 ± 5.79^{a}	33.43 ± 0.01^{bc}	28.44 ± 0.29^{cd}	2.73 ± 0.01^{e}	36.04 ± 0.06^{b}	0.00 ± 0.00^{e}	6.07
C17:0	1.98 ± 0.02^{a}	0.00 ± 0.00^{c}	0.04 ± 0.01^{c}	0.00 ± 0.00^{c}	0.15 ± 0.02^{c}	1.00 ± 0.56^{b}	0.12 ± 0.00^{c}	0.04 ± 0.002^{c}	0.06 ± 0.00^{c}	0.56
C18:0	0.52 ± 0.30^{b}	0.03 ± 0.02^{g}	0.30 ± 0.17^{f}	1.57 ± 0.91^{d}	0.55 ± 0.32^{e}	0.03 ± 0.01^{c}	0.00 ± 0.00^{g}	0.04 ± 0.02^{a}	1.35 ± 0.78^{e}	1.19
C21:0	0.25 ± 0.09^{c}	1.08 ± 0.11^{ab}	0.35 ± 0.03^{c}	0.88 ± 0.02^{abc}	1.12 ± 0.49^{ab}	1.33 ± 0.36^{a}	0.31 ± 0.13^{c}	0.24 ± 0.00^{c}	0.56 ± 0.03^{bc}	0.68
Total SFA	55.77 ± 1.34^{a}	54.48 ± 1.34^{a}	28.96 ± 0.50^{d}	59.10 ± 6.70^{a}	42.32 ± 0.82^{bc}	45.85 ± 1.2^{b}	3.73 ± 0.15^{c}	57.09 ± 0.04^{a}	7.23 ± 0.71^{e}	2.56
Mono unsaturated fatty acids										
C14:1	0.00 ± 0.00^{d}	1.04 ± 0.02^{c}	2.81 ± 0.12^{b}	4.55 ± 0.48^{a}	3.23 ± 0.05^{b}	3.05 ± 0.50^{b}	2.84 ± 261^{b}	3.41 ± 0.257^{b}	3.35 ± 0.10^{b}	0.79
C15:1	1.33 ± 0.08^{a}	0.79 ± 0.15^{b}	0.79 ± 0.02^{b}	1.29 ± 0.09^{a}	1.02 ± 0.12^{ab}	0.37 ± 0.01^{c}	0.82 ± 0.04^{b}	0.90 ± 0.15^{b}	0.99 ± 0.00^{ab}	0.36
C16:1ω7	1.49 ± 0.08^{e}	3.47 ± 1.16^{cde}	2.28 ± 0.02^{de}	3.00 ± 0.59^{de}	13.54 ± 6.60^{bc}	12.08 ± 4.54^{bcd}	11.02 ± 6.36^{bcde}	17.61 ± 8.87^{b}	31.19 ± 1.62^{a}	10.112
C17:1	1.18 ± 0.07^{bc}	0.93 ± 0.44^{c}	0.99 ± 0.00^{c}	2.71 ± 0.34^{a}	1.71 ± 0.06^{b}	1.49 ± 0.17^{bc}	1.28 ± 0.12^{bc}	1.68 ± 0.02^{b}	1.56 ± 0.16^{bc}	0.65
Total MUFA	4.00 ± 0.23^{f}	6.23 ± 0.59^{ef}	6.86 ± 0.34^{def}	11.55 ± 1.49^{b}	19.48 ± 6.62^{bc}	16.98 ± 3.98^{bcd}	15.97 ± 5.89^{bcde}	23.59 ± 9.26^{b}	37.09 ± 1.88^{a}	10.19
Poly-unsaturated fatty acids										
C18:2ω6	19.05 ± 0.02^{bc}	0.00 ± 0.00^{f}	11.17 ± 0.96^{e}	23.26 ± 2.76^{a}	14.33 ± 1.49^{de}	15.88 ± 1.15^{cd}	17.60 ± 0.42^{cd}	22.89 ± 1.80^{ab}	18.29 ± 0.02^{cd}	4.01
C18:3ω3	0.06 ± 0.02^{f}	3.74 ± 0.03^{e}	13.62 ± 0.57^{d}	26.80 ± 0.06^{a}	17.07 ± 1.13^{c}	17.46 ± 2.33^{c}	17.37 ± 0.11^{c}	27.45 ± 0.15^{a}	20.44 ± 0.48^{b}	2.73
C20: 4ω6	1.14 ± 0.16^{cd}	3.34 ± 0.20^{cd}	1.67 ± 0.14^{d}	3.61 ± 0.49^{a}	3.37 ± 0.57^{bc}	2.25 ± 0.50^{b}	2.01 ± 190^{cd}	2.08 ± 0.13^{bc}	2.58 ± 0.08^{bc}	0.50
C20:5ω3	1.34 ± 0.023^{d}	1.30 ± 0.02^{ab}	1.15 ± 0.09^{cd}	2.55 ± 0.34^{a}	1.80 ± 0.00^{ab}	1.99 ± 0.30^{c}	1.32 ± 0.08^{cd}	1.75 ± 0.04^{cd}	1.65 ± 0.06^{bc}	1.03
Total PUFA	21.55 ± 0.19^{c}	10.66 ± 0.27^{d}	27.61 ± 1.09^{c}	56.22 ± 3.53^{a}	36.57 ± 2.05^{b}	37.58 ± 4.29^{b}	38.30 ± 0.57^{b}	54.18 ± 1.86^{a}	42.957 ± 0.49^{b}	6.57

Treatments that are not significantly different at the 5% level are indicated by the same letters in the same row, Error bars are ±SE

(35.9% in alfalfa and 31.9% in diets) then the percent of MUFA (22.6% in alfalfa and 26% in diets).

Effect of remnant medicinal plants on amino acids of rabbit meat: The effect of diets containing remnants medicinal plants on the concentration of amino acids in NZ white rabbit meat presented in Table 4.

Lysine recorded the highest values with control, basil and basil+probiotics (6.18, 6.04 and 5.90, respectively) diets. While, the lowest value recorded with anise+probiotics (4.52). Methionine enrolled the highest value in fennel and fennel+probiotic (1.07 and 1.06) and the lowest values in basil and basil+probiotics (0.43 and 0.37). Phenylalanine marked the highest values with anise and anise+probiotics (9.48 and 9.07) and the lowest value of this essential amino acid was found in basil and basil+probiotic (4.44 and 4.30) diets. Leucine was the highest value in fennel, control and basil (6.62, 6.60 and 6.51, respectively) and was the lowest in anise+probiotics (5.52) diets. Whereas, the highest value of isoleucine was found in fennel (1.57) diet and the lowest was found in anise and anise+probiotic (0.94 and 0.97) diets.

Generally, the highest value of the total essential amino acids was found in fennel treatment (28.11) after that fennel+probiotics, anise and mint+probiotics (26.69, 26.10 and 26.09) treatment, whereas, the lowest value was found in basil+probiotics (23.56) diets. Also, the concentration of essential amino acids was (25.74%) as compared to total amino acids. On the other hand, lysine, phenylalanine and leucine were higher than methionine, threonine and isoleucine in all treatments. These results were disagreeing with Simonova *et al.*[6] results that indicated that threonine, lysine and serine were higher than other essential amino acids.

The highest value of the total semi- essential amino acids was found in basil+probiotic, control, fennel+probiotic and basil treatments (11.46, 11.34, 11.18 and 11.11) whereas, the lowest value was found in anise (6.25) diet. These results were disagreeing with Simonova *et al.*[6] which indicated that the concentration of essential Amino Acids (AAs) was lower in all experimental groups as compared to control group.

On the other hand, arginine was higher than histidine in all treatment and this result was agree with results which showed that arginine was higher than histidine.

Total non-essential amino acids recorded the highest values in anise and anise+probiotic (67.65 and 67.49) diets, whereas, the lowest value was found in Control, fennel and fennel+probiotics (62.73, 62.13 and 62.13, respectively).While, Simonova *et al.*[6] showed that the concentration of non-essential Amino Acids (AAs) was higher in all experimental groups as compared to control group. By comparing[6] results which appeared that the proportion of essential AAs rabbit meat was lower than that described by Hernandez and Gondret[23] (54.42 and 54.52%) with Ramirez *et al.*[20] and Moya *et al.*[24] reports about AA content of diverse meat and described the AA detection in poultry, beef, ostrich or pork. The comparison of these results and reports was rather difficult because of the lack of more

Table 4: Effect of remnants medicinal plants on amino acids concentration

Amino acids	Control	Mint	Mint+probiotics	Fennel	Fennel+probiotics	Basil	Basil+probiotics	Anise	Anise+probiotics	$LSD_{0.05}$
Essential amino acids										
Lysine	6.18±0.16^{a}	5.23±0.46^{bc}	5.75±0.10^{ab}	5.65±0.04^{ab}	5.60±0.08^{ab}	6.04±0.24^{a}	5.90±0.13^{a}	4.62±0.10^{cd}	4.52±0.18^{d}	0.63
Methionine	0.88±0.03^{ab}	0.85±0.01^{ab}	0.87±0.11^{ab}	1.07±0.08^{a}	1.06±0.09^{a}	0.43±0.23^{c}	0.37±0.21^{c}	0.69±0.01^{bc}	0.65±0.00^{bc}	0.35
Phenylalanine	5.45±0.25^{cd}	6.35±0.16^{bc}	6.09±0.03^{bc}	6.93±0.12^{b}	6.38±0.23^{bc}	4.44±1.02^{d}	4.30±0.82^{d}	9.48±0.18^{a}	9.07±0.26^{a}	1.37
Threonine	1.85±0.04^{c}	1.92±0.04^{bc}	1.95±0.00^{abc}	2.00±0.04^{abc}	2.01±0.02^{ab}	2.08±0.11^{a}	1.96±0.11^{abc}	1.52±0.03^{d}	1.40±0.01^{d}	0.15
Valine	3.49±0.02^{d}	3.63±0.05^{cd}	3.82±0.14^{bc}	4.27±0.20^{a}	3.99±0.03^{ab}	3.44±0.05^{d}	3.39±0.00^{de}	3.10±0.04^{ef}	3.09±0.08^{f}	0.29
Leucine	6.60±0.13^{a}	6.33±0.38^{ab}	6.21±0.03^{ab}	6.62±0.11^{a}	6.23±0.09^{ab}	6.51±0.16^{a}	6.30±0.27^{ab}	5.75±0.13^{bc}	5.52±0.21^{c}	0.61
Isoleucine	1.48±0.02^{ab}	1.35±0.10^{b}	1.40±0.03^{b}	1.57±0.00^{a}	1.41±0.00^{b}	1.34±0.00^{b}	1.34±0.04^{b}	0.94±0.04^{c}	0.97±0.07^{c}	0.14
Total	25.93±0.24^{bc}	25.66±0.78^{bcd}	26.09±0.19^{bc}	28.11±0.02^{a}	26.69±0.31^{b}	24.28±0.79^{de}	23.56±0.48^{e}	26.10±0.35^{bc}	25.22±0.46^{cd}	1.3893
Semi-essential amino acids										
Arginine	8.21±0.62^{ab}	7.79±0.47^{ab}	7.06±0.52^{bc}	6.48±0.55^{cd}	7.94±0.21^{ab}	8.13±0.50^{ab}	8.45±0.20^{a}	4.56±0.33^{e}	5.41±0.43^{de}	1.26
Histidine	3.13±0.18^{ab}	2.64±0.12^{b}	3.22±0.08^{a}	3.28±0.05^{a}	3.24±0.04^{a}	2.98±0.19^{ab}	3.01±0.30^{ab}	1.69±0.15^{c}	1.89±0.19^{c}	0.49
Total	11.34±0.45^{a}	10.43±0.58^{ab}	10.29±0.61^{ab}	9.76±0.50^{b}	11.18±0.25^{a}	11.11±0.68^{a}	11.46±0.49^{a}	6.25±0.31^{c}	7.30±0.19^{c}	1.2461
Non-essential amino acid										
Tyrosine	3.47±0.03^{abc}	3.72±0.14^{a}	3.57±0.00^{ab}	3.63±0.01^{a}	3.22±0.10^{cd}	3.00±0.13^{d}	3.02±0.02^{d}	3.24±0.09^{cd}	3.28±0.17^{bcd}	0.30
Cysteine	0.00±0.00^{b}	3.03±1.56^{a}	0.00±0.00^{b}	0.00±0.00^{b}	0.00±0.00^{b}	0.00±0.00^{b}	1.39±0.80^{ab}	0.92±0.92^{ab}	2.57±1.47^{a}	2.56
Glycine	1.97±0.21^{a}	1.68±0.04^{a}	1.74±0.01^{a}	2.26±0.40^{a}	1.80±0.07^{a}	1.97±0.16^{a}	2.10±0.27^{a}	0.16±0.14^{b}	0.46±0.21^{b}	0.64
Serine	3.10±0.11^{cd}	3.61±0.11^{a}	3.24±0.03^{bc}	3.34±0.06^{bc}	3.27±0.07^{bc}	3.40±0.09^{ab}	3.36±0.03^{b}	2.88±0.06^{d}	2.87±0.11^{d}	0.24
Alanine	6.21±0.10^{de}	5.33±0.39^{f}	6.18±0.00^{e}	7.03±0.43^{b}	6.43±0.09^{cde}	6.74±0.01^{bcd}	6.91±0.03^{bc}	8.28±0.02^{a}	8.35±0.02^{a}	0.55
Glutamic	43.31±0.40^{cd}	41.44±0.57^{ef}	43.57±0.58^{c}	40.35±1.09^{f}	42.22±0.66^{cde}	43.24±0.68^{cd}	42.02±0.84^{de}	47.63±0.64^{a}	45.54±0.46^{b}	1.37
Aspartic	4.67±0.51^{c}	5.11±0.35^{bc}	5.32±0.14^{abc}	5.52±0.16^{abc}	5.20±0.10^{abc}	6.27±0.68^{a}	6.17±0.69^{ab}	4.53±0.07^{c}	4.42±0.11^{c}	1.12
Total	62.73±0.69^{c}	63.91±0.19^{bc}	63.62±0.42^{bc}	62.13±0.48^{c}	62.13±0.55^{c}	64.61±1.47^{b}	64.98±0.97^{b}	67.65±0.35^{a}	67.49±0.65^{a}	1.87

Treatments that are not significantly different at the 5% level are indicated by the same letters in the same row, Error bars are ±SE detailed studies on rabbit meat concerning the AA composition. Whereas, this study was indicated that total non-essential amino acids (62.13 and 67.65%) was higher than total essential amino acids (23.56 and 28.11%) in all treatments, while, Simonova *et al.*[6] showed that total essential amino acids (51.83 and 52.67%) was higher than total non- essential amino acids (47.33 and 48.20%).

CONCLUSION

In this study, an attempt has been made to identify the effect of using some remnant of medicinal plants on New Zealand white rabbit meat quality, fatty and amino acids, even if to a different extent could be summarized as follow: (1) The quality of rabbit meat in all treatment was higher because it contained less fat and the quality of protein was higher, (2) Results of chemical analysis of meat showed that rabbits fed basil diets recorded the highest value of meat moisture, ash and total lipid, (3) By comparing all treatments results of fatty acids analysis of meat observed that the highest proportion of total SFA and total PUFA has found in rabbits fed fennel diets (59.10 and 56.22%), whereas the highest proportion of MUFA has found in rabbits fed anise+probiotics diets (37.09%) and (4) Results of amino acids analysis of meat showed that the highest value of the total EAA has found in fennel treatment (28.11), the highest value of the total semi-essential amino acids has found in basil+probiotic (11.46%). On the other hand, total non-essential amino acids recorded the highest values in anise (62.73%).

SIGNIFICANT STATEMENT

The significance of this study for the disposal of remnants and eliminate pollution of the environment and to feeding rabbits on healthy food without industrial components.

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