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Effect of substituting hydroponic barley for a commercial feed on performance and blood metabolites of growing *Baladi* rabbits

H. SHANTI [1], J. OMAR [2*], IN. ALWAHEIDI [1], J. ABDALLAH [2], E. DBADRAN [3]

[1] Department of Animal Production and Animal Health, Faculty of Agriculture, Azhar University, Gaza, Palestine
[2] Department of Animal Production and Animal Health, Faculty of Agriculture, An Najah National University, Nablus, P. O. Box 707, Palestine
[3] National Agriculture Research Center (narc), Palestine

*Corresponding author: jamal.aboomar57@najah.edu

Abstract - The effect of replacing a commercial feed with hydroponic barley (HB) was studied on feeding trial to investigate its effects on performance, visceral organs and blood biochemistry of growing local *Baladi* rabbits. Four mixed diets based on a pelleted commercial rabbit feed (18% crude protein) were made by substituting HB (containing 18% dry matter, 2% crude protein and 15% crude fiber) for the commercial feed (0, 20, 40 and 60%). Sixty four*Baladi* rabbits, 32 d of age and with an average body weight (±standard error) of 525 ± 10 g were assigned to the 4 treatments and caged in groups of 4 rabbits (2 females and 2 males/ cage). HB was grown for 8 d, and fed immediately after harvesting, including roots, seed and leaves. Feed intake and growth rate from 32 to 74 d of age were recorded. The rabbits were then slaughtered and the dressing proportions was calculated.Dry matter feed intake and growth rate decreased linearly by 1.16±0.080 g/d (P<0.001) and 0.998±0.062 g/d (P<0.001) per unit of HB increase. Rabbits consumed daily all the HB offered 0, 6.4, 12.8, and 19.1 g DM for 0, 20, 40 and 60% substitution levels, respectively. Both crude protein and digestible energy intake decreased linearly by 0.24±0.071 g/d (P<0.001) and 2.88±0.040 MJ/d (P<0.001). Feed conversion (average 3.45±0.20) and carcass yield percentage (average 56.25±0.42 %) were not affected by treatments. Blood metabolites were within the MEDIRABBITstandards; however, level of HB had variable effects on visceral organs. It was therefore concluded that replacing pelleted commercial feed by wet HB had negative effects on rabbits' performance.

Keywords: rabbits, performance, hydroponic barley, carcass, blood metabolites

1. Introduction

The domestic rabbit (*Oryctolagus cunniculus*) is an excellent source of good quality meat. Rabbit meat is of high protein and low cholesterol compared to that of ruminants (Aduku and Olukosi, 1990). Rabbits do not compete with chicken and turkey on feeds. As a hind-gut fermenter, it can utilize the available proteins in cellulose-rich plants. The animals' performance and lower feeding costs are major concerns by researchers all over the world. In the diets for nonruminants (*i.e.* broilers, rabbits) nearly 75% of livestock operation costs are associated with feed cost (Issa andAbo Omar, 2012).

The technology of green fodder production is especially important in Palestine where forage production is limited (Abo Omar, et al.2012). The green fodder is produced from grains, having high germination rate and grown for a short period of time in a special chamber that provides the appropriate growing conditions(Saidi and Abo Omar 2015;Sneath, andMcIntosh, 2003).

The germination process takes 8 to 10 d period to reach the hydroponic sprout using solar energy(FAO, 2001). Plastic trays of suitable dimensions placed on metal stand are used in the germination process(Saidi and Abo Omar, 2015). At harvest, the plant is 20 to 25 cm in height, consisting of stem, green leaves and roots (Shtaya,2004). The animal consumes the whole plantincluding seed and roots (Resh, 1997). Because of its aspect, color, taste and texture, it is considered ahighly palatable feed that promotes digestibility of other nutrients(FAO, 2001).

The adoption of this technique has enabled production of fresh forage from oats, barley, wheat and other grains(Saidi and Abo Omar, 2015).Limited research has been conducted on the feeding value of sprouted grain.

The objective of this study was to investigate the performance, visceral organ mass and blood metabolites of *Baladi* rabbits fed HB as part of commercial rabbit feed.

2. Materials and methods

2.1. Study site

The study was conducted at the farm of Azhar University, Gaza city, Palestine, which is a coastal area, after approval of the University Animal Care and Use Committee.

2.2. Production of HB

Production of HB was conducted under temperature controlled conditions (22 ± 1°C) and natural illumination in growth chamber at the project site, Gaza city, Palestine.

Hydroponic system is composed of a hydroponic chamber with an area of 33 m^2. The chamber is composed of metal frame and shelves. Shelves in the chamber hold 126 trays with capacity of chamber to produce approximately one ton of green fodder per growth cycle (8 days). Plastic trays with dimensions 90 x 30 x 4 cm were used for growing barley grains. These trays were obtained from the local market of Gaza city, Palestine. An air conditioning was used to control temperature inside the growth chamber which was maintained at 22 ± 1°C. The relative humidity in the growth room was 65%.

Animals, design, dietary treatments and analytical methods

Sixty-*four Baladi* 32 d-old rabbits, with an average initial weight (±standard error) of 525±10 g were assigned to the 4 treatments and caged in groups of 4 rabbits (2 females and 2 males/cage). A pelleted commercial feed was used as control diet (C). The other three treatments were obtained by replacing 20, 40 and 60% of pelleted control feed by HB (HB20, HB40 and HB60, respectively). Rabbits were supplied with (% pelleted feed/ % wet HB): 80/20, 60/40 and 40/60. Chemical composition of commercial feed and HB is shown in Table 1. The amounts of pelleted commercial feed and HB offered per week in each treatment are shown in Table 2. Pelleted feed and HB were provided in different feeders. Rabbits were treated with IVOMEC (Merial Limited, Luluth, GA, USA) and Cogla Vac (Cogla Laboratories, Libourne, France) against internal and external parasites, and enterotoxaemia, respectively, immediately prior to the start of the experiment. Rabbits were kept in cages measuring 90×60×40 cm, equipped with two hopper-type feeders and automatic nipple drinkers. Average temperature in the area was 20 ºC. Feed consumption was obtained daily by weighing the amount offered and the amount remaining per cage and rabbits were weighed weekly. Feed conversion was obtained from the sum of the dry HB intake and dry matter intake of pelleted commercial feed divided by rabbit weight gain. Digestive problems and mortalities did not occur during the study.

Table 1. Proximal chemical analysis of pelleted commercial feed and hydroponic barley (HB) (% dry matter basis).

	Commercial feed	HB
Moisture % as fed	13	82
Crude protein	18	2
Ether extract	3.5	2.5
Crude fiber	13	15
Nitrogen free extract	53	62
Ash	12	5
Digestible energy; kcal/kg	2540	2400

Table 2. Amount of balanced commercial feed (CF) and wet hydroponic barley (HB) offered daily per rabbitduring the 6 weeks of the experiment1.

	C		20HB		40HB		60HB	
	CF	HB	CF	HB	CF	HB	CF	HB
Week1	100	0	80	20	60	40	40	60
Week2	130	0	104	26	78	52	52	78
Week3	155	0	124	31	93	62	62	93
Week4	176	0	141	35	105	71	70	106
Week5	193	0	154	39	115	77	77	116
Week6	207	0	165	42	124	83	82	124

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2.3. Chemical analysis

The experimental rations were analyzed (three samples from each ration) according to procedures of AOAC(1990) forDM (105 ◦C in a forced- air oven for 48 h), organic matter (OM; weight loss upon ashing at 550◦C for 8 h), crude protein (CP; Kjeldahl procedure) and ether extract (EE; Soxhlet procedure, Soxtec System, TECATOR, Hoganas, Sweden) and crude fiber AOAC(1990)(962.09). The DE values werecalculated based on NRC (1966) feed composition tables.

2.4. Blood collection

Blood samples were collected into labeled Ethylene-deamine-tetra-acetic acid (EDTA)treated tubes for haematological analysis and into tubes without anticoagulant for serum biochemical evaluation.Evaluations were conducted according to the method of Bitto and Gemade(2001).

2.5. *Slaughtering procedure*

At the end of the experiment (age of 74 d), all rabbits were slaughtered after an 18 h fast according to routine procedures at local commercialslaughter facilities. Fasted-live and hot carcass weights were recorded before and immediately after slaughter. Directlyafter slaughter, non-carcass components (i.e., head and feet, lungs and trachea, heart, liver, kidneys) were removed and weighed. Carcasses were chilled at 4 ◦C for 24 h and cold carcass weights were recorded. Dressingproportion was calculated as the hot carcass weight proportion of fasted BW. Empty body weight and weights of edible parts (carcass without head, liver, heart, kidneys and lungs) were recorded.

2.6. Statistical analyses

The linear effects of HB on dry matter,digestible energy, and crude protein werestudied using regression analysis. Analysis of variance was used to test the significance of HB inclusion rates on productive performance indicators, visceral organ percentages, and blood metabolites. Duncan’s multiple range test was used to test differences among treatment means with using significance level of 0.05. These analyses were performed using SAS statistical analysis software SAS (2002).

3. Results and discussion

All of the HB offered was totally consumed but pelleted feed always remained in feeders. Results for feeding trial and carcass yield in rabbits, during the 42 d experiment with the addition of HB are shown in Table 3. Inclusion of HB caused a linear reduction in pelleted feed intake (P<0.001). Total dry matter intake was also linearly decreased (P<0.001) by 1.16±0.80 g/d per additional unit of HB. This could be explained by the bulky nature of the wet HB which could have limited feed intake of the pelleted diet.Both estimated crude protein and digestible energy fed were decreased (P<0.001) with HB inclusion **(**0.24±0.074g/d, and 2.88±0.040 MJ/d),respectively**.** Average daily gain also decreased linearly (P<0.001) by0.998±0.062 g/dper additional unit of HB. However, feed conversion ratio was not affected by HG inclusion(3.45±0.20 on average), nor was dressing proportions (56.25±0.42 %, on average).The reduction in digestible energy and crude protein caused by feeding HB resulted in ration levels lower than that recommended by the NRC (1966).The DE and crude protein levels in the feeding trial failed tomeet the rabbits’ requirements and impaired their performance.

Table 3: Effect of balanced dry feed replacement with hydroponic barley (HB)on productive parameters of growing *Baladi* rabbits (mean±SEM) (n=4 cages/treatment except for dressing-outperformance, where n=16 rabbit/treatment).

	C	20HB	40HB	60HB	P value
Daily dry matter intake, g/rabbit					
Total	144^{a}±7.66	122^{b}±5.34	98^{c}±4.78	75^{d}±4.00	0.001
Pelleted feed	144^{a}±8.0	115^{b}±8.88	86^{c}±5.99	57^{d}±6.77	0.001
HB	0^{d}	7^{c}±0.90	12^{b}±1.20	18^{a}±1.98	0.001
Final weight	2251.0^{a}±23	2032.8^{b}±17b	1634.8^{c}±18c	1440.6^{d}±21	0.001
Daily weight gain, g	41.1^{a}±3.13	35.9^{b}±3.11	28.8^{c}±3.00	21.8^{d}±2.90	0.001
FCR	3.5±0.34	3.4±0.23	3.4±0.90	3.5±0.56	0.856
Dressing percentage, %	56±4.21	56±5.00	57±5.10	56±5.30	0.364

[1] C, 20HB, 40HB and 60HB refer to dietary treatments containing 0, 20, 40 and 60 % hydroponic barley, respectively.
[a,b] Means within rows with different superscript differ significantly (P < 0.05) using Duncan’s multiple range test.

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Energy and protein are the most important factors required to obtain maximum weight gain (Lebas, 1989; Morales et al. 2009).It was proposed that a feed should contain a DE of about 10.5 MJ DE/ kg DM (Santomá, et al. 1989).They showed that optimum rabbit performance is expected when fed diets with DE levels of at least 9.5 MJ/kg DM. In this study the average daily crude protein and DE intake ranged from 15 to 28 g and 0.85 to 1.5 MJ (Fraga et al.1989) calculated that a rabbit with an average growth rate of 35 g/d required around 1.09 MJ/d and 17.3 g crude protein/d. According to this,the poor performance observed in rabbits fed the highest level of HB (60HB) could be explained by the deficit of DE and crude protein intake.However, the performance observed in other rabbits that fed with lower HB levels (20HB and 40HB) would not be explained by a crude protein or digestible energy deficiency but could be accounted for by the higher requirements of rabbits compared to levels recommended by other research**.** Similar findings were reported by Morales et al.(2009) and Huang et al. (1998)where poor rabbit's performance was found when fed diets with DE and crude protein levels within the recommended levels**.**De Blas et al. (1986) and Morales et al.(2009) reported that growth in rabbits decreases with diets with low levels of fiber. In this study, level of crude fiber was 15 % which is within the range recommended by other research(Blas et al. 1986). Similar findings were reported by Morales et al. (2009) where level of fiber was 13.5%and caused similar effects on rabbits when fed increasing levels of HB.

Inclusion of HB had variable effects on rabbits' visceral organs (table 4). Higher levels of HB inclusion (40 and 60%) caused a significant increase (P <0.05) in gall bladder and heart weights. Other visceral organs were not affected by HB feeding.

Table 4: Visceral organ percentages of local *Baladi* rabbits fed different levels of HB

		Treatment			
Parameter	**C**	20HB	40HB	60HB	P value
Blood	97.23±0.63	96.8±0.33	96.9±0.26	97.2±0.22	0.120
Skin	8.42±0.17	7.5±0.16	9.06±0.24	8.8±0.09	0.090
Feet	3.02±0.03	2.9±0.02	2.9±0.03	3.41±0.11	0.080
Head	9.44±0.16	9.0±0.07	8.82±0.05	9.45±0.05	0.121
Intestines	20.24±0.17	23.8±0.79	20.9±0.02	23.29±0.37	0.064
Liver	3.26±0.17	2.7±0.01	3.11±0.17	2.98±0.05	0.151
Kidneys	0.53±0.07	0.6±0.0	0.65±0.01	0.62±0.01	0.285
Spleen	0.20±0.04	0.15±0.0	0.14±0.0	0.16±0.0	0.250
Gallbladder	0.14±0.01	0.15±0.0	0.14±0.0	0.15±0.0	0.004
Heart	0.33^{b}±0.01	0.30^{c}±0.0	0.36^{a}±0.01	0.37^{a}±0.03	0.024
Lungs	0.68±0.05	0.65±0.03	0.84±0.01	0.71±0.05	0.240

[1] C, 20HB, 40HB and 60HB refer to dietary treatments containing 0, 20, 40 and 60 % hydroponic barley, respectively.
[a,b] Means within rows with different superscripts differ significantly ($P < 0.05$) using Duncan's multiple range test.

Blood metabolites were variably affected by the diets fed (Table 5).Feeding HB had no effects on creatine, albumen, globulin and AST. However, HB decreased levels of blood urea and total protein and had variable effects on other blood metabolites as cholesterol, triglycerides and Alt. levels of measured blood metabolites are within the MEDIRABBIT (2007) range.

Table 5: Effect of feeding different levels of HB on some blood metabolites of local *Baladi* rabbits.

	Treatment [1]				P value
	C	20HB	40HB	60HB	
n	16	16	16	16	
Urea, mg/dl	44.0^a±2.1	31.6^b±0.8	28.0^b±1.5	31.6^b±0.3	0.000
Creatine, mg/dl	0.9±0.19	1.1±0.03	1.0±0.07	1.0±0.06	0.529
Total protein, g/l	5.7^a±0.06	5.3^b±0.19	5.3^b±0.06	5.1b±0.03	0.032
Albumin, g/l	3.8±0.06	3.6±0.06	3.5±0.09	3.6±0.06	0.095
Globulin, g/l	1.9±0.06	1.7±0.23	1.7±0.07	1.5±0.07	0.394
A/G[2]	2.0±0.08	2.1±0.3	1.9±0.13	2.2±0.12	0.582
AST[3], IU/l	56.6±8.4	49.0±0.58	61.0±5.5	55.3±2.4	0.474
ALT[4], IU/l	32.0^b±1.5	29.0^b±0.58	52.6^a±4.9	30.3^b±2.6	0.001
Cholesterol, mg/dl	63.0^c±10.2	70.3^a±0.33	41.3^d±2.4	67.3^a±3.3	0.022
Triglycerides,mg/dl	107.0^b±8.2	71.0^d±7.1	98.3^c±8.1	116.0^a±7.8	0.002

[1] C, 20HB, 40HB and 60HB refer to dietary treatments containing 0, 20, 40 and 60 % hydroponic barley, respectively.
[2] Albumin/ globulin.
[3] aspartate transferase.
[4] alanine transferase. [a,b] Means within rows with different superscripts differ significantly (P < 0.05) using Duncan's multiple range test.

4. References

Abo omarJM, Daya R, Ghaleb A (2012). Effects of different forms of olive cake on the performance and carcass quality of Awassi lambs.Anim feed Sci . Tech. 171: 167–172**.**

Aduku AO, Olukosi JO (1990). Rabbits Management in the Tropics, Books Gospel Publication, Abuja, pp40.

Associationof Official Analytical Chemists(AOAC) 1990. Official methods of analysis. AOAC, Washington, DC, USA.

Bitto II, Gemade M, Afri. J (2001) Biomed. Res. 9:199-209.

Blasco A., Ouhayoun J, MasoeroG (1993) Harmonization of criteria and terminology in rabbit meat research. World Rabbit Sci.1:3-10.

Chat TH, Dung NT, Binh DV, Preston TR (2005) Livestock Research for Rural development.17:10.

Cheeke PR (1955) Alimentacióny nutrición del conejo. Ed. Acribia. Zaragoza, España.

MEDIRABBIT (2007) www.medirabbit.com/EN/Hematology/blood_chemistry.htm ; www.Irrd.org/Irrd17/10/chat17109.

DE Blas JC, Santoma G, Carabono R, Fraga MJ (1986) Fiber and starch levels in fattening rabbit diets. J. Anim. Sci.63: 1897-1904.

FAO (Organización de las Naciones Unidas para la Agricultura y la Alimentación). (2001) Manual técnico forraje verde hidropónico. Santiago de Chile, Chile.

Fraga MJ (1986) Necesidades de nutrientes. In: De Blas J.C., (ed). Alimentación del conejo. 2ª ed. Mundi-Prensa, Madrid, España;61-74.

Huang XS, Zheng ZD, Fang JM, Wu JC, Fu CZ (1998) Nutrition improvement for rabbits by feeding orchard-growing forage.

Issa K, Abo Omar J(2012) Effect of garlic powder on performance and lipid profile of broilers. Open Journal of Animal Science.2: 62-68

Lebas F (1989) Besoins nuttritionnels des lapins. Cuni-Sciences.**5**: 1-27.

Morales MA, Fuente B, Juárez M, Ávila E (2009) Effect of substituting hydroponic green barley forage for a commercial feed on performance of growing rabbits.World Rabbit Sci.17: 35 – 38.

(NRC)National Research Council (1966) Nutrient Requirement of Rabbits, 1st revised ed.National Academy Press, Washington, DC, USA.

Resh HM (1997) Cultivos hidropónicos. 3ª ed. Mundi-Prensa España. Samperio R.G. Hidroponía básica. Ed. Diana, México,1997.

SaidiA, Abo Omar J (2015) Economical and biological fasibility of hydroponic barley fed to lactating Awassi ewes. Master of Science theses. Open Journal of Animal Science.

Santomá G, De Blas JC, Carabaño R, Fraga MJ (1989) Nutrition of rabbits. In: Recent Advances in Animal Nutrition. Haresing W.,Cole D.J.A.. (Eds). Buttherworths. UK. 109- 138.

SAS (2002) SAS User's Guide: Statistics. SAS Institute Inc., Cary, NC, USA.

Shtaya I (2004) Performance of Awassi lambs fed different levels of hydroponic barley. Master of Science theses. An Najah National University, Nablus, Palestine.

Sneath R,McIntosh F (2003) Review of hydroponic fodder production for beef cattle. Department of Primary Industries: Queensland Australia 84, McKeehen,pp: 54.