THE EFFECT OF FERMENTED PURPLE SWEET POTATO (*Ipomoea batatas* L) IN THE RATION ON THE ANTIOXIDANT PROFILE AND MEAT CHOLESTEROL OF BALI DUCK

Tjokorda Gede Belawa Yadnya, Ida Bagus Sudana, I Gede Mahardika, and I M.Mastika
Faculty of Animal Husbandry , Udayana University
Jl. PB Sudirman. 80361 denpasar ,Bali-Indonesia

belawayadnya_fapet@yahoo.com, Phone : (0361295635)

ABSTRACT

An experiment was carried out to the study the effect of fermented purple sweet potato (*Ipomoea batatas* L) in the ration on the profile antioxidant and meat cholesterol of bali duck. A Completely Randomized Design (CRD), consisted seven treatments and four replicates each was used in this experiment. The seven treatments were ration without purple sweet potato (*Ipomoea batatas* L) (treatment A), ration containing 10, 20, and 30% un fermented purple sweet potato (treatment B, C, and D), ration containing 10, 20, and 30% fermented purple sweet potato (treatment E, F, and G). Each treatment consisted of four replicates with four ducks in each replicates with homogenous age and weight. The variables observed including profile antioxidant, antioxidant capacity, *malondialdehida* (MDA), and *superoxida dismutase* (SOD); lipid profile : total clolesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), and triglyceride. Feeds offered were iso nitrogenous and iso calory and were given *ad lid*

The result showed that using fermented purple sweet potato in the ration improved antioxidant profile that was increased of antioxidant capacity such as *superoxida dismutase* (SOD) were significantly (P<0,05), and malondialdehida (MDA) decreased was sinificantly (P<0,05) than those given control diet..

Ducks meat offered control diet contained total cholesterol and LDL 107,66 mg/100 g and 45,55 mg/100g respectively, When offered diet containing un fermented purple sweet potatoes decreased the content of cholesterol and LDL significantly (P<0.05) compared to control.

Result of the experiment suggested that the effect of fermented purple sweet potato (*Ipomoea batata*s L) in the ration improved the antioxidant profile and consentration of the meat cholesterol of bali duck.

Key words: purple sweet potato (Ipomoea batatas L), fermented, antioxidant profile, meat cholesterol, and bali duck

INTRODUCTION

The population of Indonesia increase steadily causing , increasing the need for animal protein from cattle. To meet these needs can be obtained from several ruminant meat such as cows, goats, sheep, as well as a small part of the pig. Besides poultry meat also play an important role in meeting those needs, especially meat from free-range chicken about 187 ton, broiler586 ton , and 14.3 tons of ducks totally is almost 42.35% of 1894.4 tons required nationwide meat from poultry in 2010 and 7,65% of that figure comes from duct meat.

Duck meat as a source of animal protein has a disadvantage because contained high-fat which is about 25,71% (Setyawardani *et al*., 2001). High-fat meat has abad connotations becaused of the high cholesterol content and has been reported to have abad risk to human health. Therefore it is necessary to lower cholesterol levels in the duck meat.

To reduce levels of cholesterol in meat can be done by feeding the animal with diet containing antioxidants and one of them is by giving the purple sweet potato (*Ipomoea batatas* L) (Kumalaningsih, 2008). Agarwal and Rao (2000) state that an antioxidant compound can lower and cholesterol levels in the body by inhibiting the activity of the enzyme 3 hydroxy , 3-Methyl-Ko.A Gluteril reductase, thus resulting the production of mavalonat acid is limited, so it will affect the cholesterol level lower. Sumardika and Jawi (2011) reported the extract of purple sweet potato leaves can reduced cholesterol levels and increase levels of *superoxide dismutase* (SOD) on mice blood. Prangdimurti *et al.* (2006) reported that administration of the leaf extract suji leave (*Pleomele ongustifolio*) in rat Sprague Dowley male increased the antioxidant capacity, *superoxide dismutase* (SOD) and lower ad the levels *of malondialdehida* (MDA)

Based on the above report research was conducted to study "The effect of fermented purple sweet potato (*Ipomoea batatas* L) in the ration on antioxidants profile and meat cholesterol of bali duck".

MATERIALS AND METHODS

Place and Period of The Experiment

The experiment was conducted in Guwang village, Gianyar Recency of Bali Province for 16 weeks, while the determination of meat cholesterol was conducted in the Laboratory of Animal Nutrition Feed, Faculty of Animal Husbandry for 4 weeks. Meat Antioxidant Profile analysis was conducted in the Laboratory of Analytic, Udayana University for 4 weeks.

Material and Equipment

The ducks used in the experiment were 16 weeks old male ducks bought from I Wayan Pegeg, Guwang village which were originally obtained from ducks breeder in Bringkit, Badung Regency.

Tubers of purple sweet potatoes (*Ipomoea batatas* L) was imparted at Banyuwangi, *Aspergillus niger* used in this study was obtained from the Institute for Agricultural Technology (BPTP) Denpasar.

Table 1. Feed Composition of Duck Age 16 – 32 Weeks

Inggredients (%)	Treatment						
	A	B	C	D	E	F	G [1)]
Yellow corn	55,36	49,98	42,32	35,5	49,98	42,32	37,20
Soybean	9,37	12,45	13,88	15,40	12,45	13,88	15,40
Copra meal	11,31	9,82	7,28	3,06	9,82	7,28	3,06
Fish meal	10,13	8,10	10,29	11,14	8,10	8,29	8,14
Rice bran	13,26	9,00	5,56	4,25	9,00	7,58	5,25
Purple sweet potatoes meal	-	10,00	20,00	30,00	-	-	-
Fermented purple sweet potatoes meal	-	-	-	-	10,00	20,00	30,00
Premix	0,50	0,50	0,50	0,50	0,50	0,50	0,80
Coconut oil	1,00	-	0,50	1,00	-	1,00	1,00
NaCl	0,15	0,15	0,15	0,15	0,15	0,15	0,15

[1)] A : Control treatment (without purple sweet potato) B : Ration contain 10,0 % purple sweet potato C : Ration contain 20,0 % purple sweet potatoD : Ration contain 30,0 % purple sweet potat E : Ration contain 10,0 % fermented purple sweet potato F : Ration contain 20,0 % fermented purple sweet potato G : Ration contain 30,0 % fermented purple sweet potato

Table.2 Chemical **Composition 0f Ducks Feed Age 16 – 32 Weeks (calculated)**

Nutrien	Treatment [1)]							Standard [2)]
	A	B	C	D	E	F	G	
Metabolic Energy (Kcal/kg)	2907.07	2878,2	2904.3	2887.28	2886,1	2882.18	29052	2800 - 2900
Crude Protein (%)	17,00	16,68	17,18	16,87	16,67	1701	16,99	15 - 17
Ether Extract (%)	5,75	5,92	5,61	5,38	5,85	5,84	5,17	4 – 7
Crude Fiber (%)	4,56	4,42	4,20	4,00	4,36	4,23	4,0	4 – 7
Calsium (%)	1,00	0,94	0,97	0,96	0,94	0,92	0,91	0,80
Phosphor available (%)	0,60	0,50	0,50	0,50	0,51	0,50	0,50	0,70
Methionine (%) + Cystine (%)	0,82	0,86	0,87	0,90	0,80	0,85	0,86	0,55
Lysine (%)	1,37	1,35	1,41	1,43	1,34	1,28	1,34	0,80
Methionine (%)	0,52	0,56	0,59	0,71	0,57	0,61	0,65	0,30

1) A : Control treatment (without purple sweet potato) B : Ration contain 10,0 % purple sweet potato C : Ration contain 20,0 % purple sweet potatoD : Ration contain 30,0 % purple sweet potat E : Ration contain 10,0 % fermented purple sweet potato F : Ration contain 20,0 % fermented purple sweet potato G : Ration contain 30,0 % fermented purple sweet potato

2) Scott *et al.(*1982).

The ration was composed based on Scott *et al.* (1982) recommendation . Ingredients and nutrient composition were presented in Table 1 and Table 2.

Feed and drinking water were provided *ad libitum*.

Design of the experiment

A completely Randomized Design was used in this experiment The treatments consisted of A : Control feed (without purple sweet potato). Diet B, C and D containing 10%, 20%, and 30% purple sweet potato meal while Diet E, F and G containing 10%, 20%, and 30% fermented purple sweet potato meal respectively. Each treatment consisted of four replicate and each replicate consisted of four bali ducks.

Variables Measured

During the experiment, the variables measured antioxidant consumption , Antioxidant Capacity were carried out following the method of Okawa *et a*l., (2001), *Malondialdehide* (MDA) with Thiobarbituric acid reactive substannce methods

(Wuryastuti, 1996), *Superoxide dismutase* (SOD) with oxiselect *Superoxide dismutase* (SOD) activity methods Cell Biolab (2004). Determination of total cholesterol following the method of Liebermann – Burchad which have been modifide by Udin *et al*.(1996). For analysis countent of HDL, LDL and Triglyceride was determined using Phosphotungstic acid magnesium chlorid methods.

Statistical Analysis Methods

Data collected in the experiment was tabulated and analyzed using analiysis of variance. When statistical differences between treatment were found, the analysis was continued with Duncan' s multiple range test to compare the two treatment means (Steel and Torrie, 1989).

RESULTS AND DISCUSSION

Antioxidant Profile

Antioxidant consumption of ducks with control diet (ration without purple sweet potato) was 9.00 g/head/16 weeks (Table 1). Those offered treatment B, C, D, E, F, and G has increased antioxidant consumption 21.33%; 21.88%; 23,22%; 23.55% and 45.88% respectively and the different significantly (P<0.05) compared with treatmentA.

The higher consumption of antioxidants in the diet containing purple sweet potato either fresh or fermented, because the purple sweet potato contained anthocyanins substances as source precursor antioxidants (Kumalaningsih, 2008). Yadnya and Tresnadewi (2011) reported that fermentation of purple sweet potato has increased anthocyanin and antioxidant content significantly, so that consumption of antioxidant also increased ration higher than giving diet containing fermented purple sweet potato without or without the purple sweet potato.

Table.3 The Effect of Fermented Purple Sweet Potato (*Ipomoea batatas* L) in the Ration on the Antioxidant Profile of Bali Ducks Meat

Variables	Treatments [1)]							SEM [3)]
	A	B	C	D	E	F	G	
Antioxidant Consumption (g/head/16 weeks)	9,00 [d]	9.77 [c]	10.92 [b]	11.09 [b]	10.97 [b]	11.12 [b]	13.13 [a 2)]	123.62
Capacity of. Antioksidan (% IC)	15..83 [e]	17.20 [d]	18.38[c]	18.97[c]	18.35[c]	20.51[b]	23.70 [a]	0.2740
SOD (µ//kg)	0.47 [f]	0.58 [e]	0.64 [d]	1.03 [d]	1.24 [c]	1.33 [b]	1.46 [a]	0.0263
MDA(mg/ kg)	1.97[a]	0.77[b]	0.76[b]	0.73[bc]	0.66 [c]	0.56 [d]	0.47 [e]	0.0264

:

1) A : feed without purple sweet potato (*Ipomoea batatas* L)

Feed containing 10%; 20%; and 30% purple sweet potato without fermented (B, C, and D)
Feed containing 10%; 20%; and 30% fermented purple sweet potato (E, F, and G)

2) Value with same superscripts in the same row indicates no significant difference (P>0.05)
3) SEM : " *Standard Error of the Treatment Means"*

Diet the antioxidant capacity, *Superoxide dismutase* (SOD) and *Malondialdehide* (MDA) on each duck meat fed control were 15.83% IC; 0.47 μ / kg and 1.97 mg / kg (Table 3). On the other hand , when fed offered diets B, C, and D had the antioxidant content such as SOD, MDA significantly higher than control. This is due to higher consumption of antioxidants ration causing radical neutralizing ability was increasing significant defferent (P<0,05).Kumalaningsih (2008) reported the presence of vitamin C, vitamin A and E along with Zn, Se and Cu in purple sweet potato acts as an antioxidan has antioxidant capacity similar as treatment B, C, D, E, F, and G are higher than treatmen A

The increase in SOD content in the meat is strongly influenced by the intake of vitamin C and Zn and Se elements that help increase activity than SOD (Hillbom, 1999). Sumardika and Jawi (2011) reported that the extract of purple sweet potato leaves increased significantly.Those meat of ducks offered of purple sweet potato either unfermented or fermented in the diets reduced levels of *Malondialdehide* (MDA) significantly lower compared the duck of treatment A. The decreased levels of MDA's meat due the higher antioxidant capacity, *superoxide dismutase* (SOD) were higher (P <0.05) than that of the control treatment. Prangdimurti *et al.* (2006) reported the containing antioxidants could increased the antioxidant capacity and SOD, but decrease MDA levels of blood serum of rats. The same result was infated under nadt. Jawi *et al.* (2008) that the extract of purple sweet potatoes can lowered *malondialdehide* on the blood serum and liver of the rats

Meat lipid profile (cholesterol, triglycerides, LDL and HDL) pattern similar as the pattern of blood lipid profile. Cholesterol, HDL, and LDLof ducks meat was lower (P <0.05) in ducks consumed fermented purple sweet potato diet, but the meat triglyceride levels was not significantly so.

Duck meat cholesterol levels who received treatment control diet was 107.66 mg/100gr. (Table.4). Treatment B causing total of cholesterol content 17.51%.

However it was not significant differences (P> 0.05), while the conavite was true for treatment C, D, E, F, and G. Distribution of meat lipid profile indicated in Figure 1.

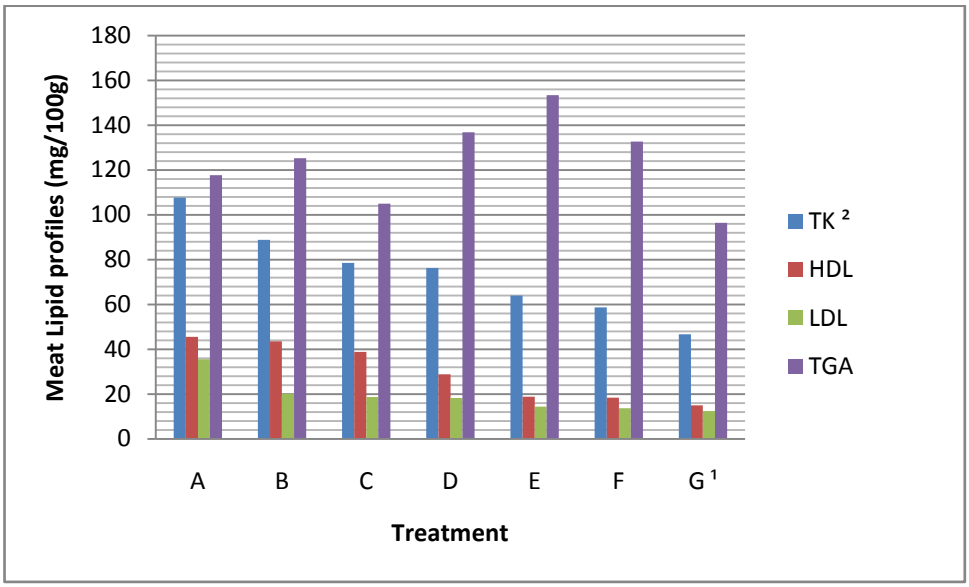

Figure 1
Meat Lipid Profile on offered Fermented Purple Sweet Potato (*Ipomoea batatas* L) in the ration of Bali Duck

1) A : Control treatment (without purple sweet potato), B : Ration contain 10,0% without fermented purple sweet potato, C : Ration contain 20% without fermented purple sweet potato, D : Ration contain 30% without fermented purple sweet potato , E : Ration contain 10% fermented sweet potato, F : Ration contain 20% fermented purple sweet potato, and G : Ration contain 30% fermented purple sweet potato .
2) TK : Total Cholesterol ; HDL : *High Density Lipoprotein ;* LDL *: Low Density Protein;* TGA *: Trigliserida*

Fig.1, illustrating that the higher of fresh purple sweet potato or fermented can lower meat cholesterol concentrations and were followed by decreased levels of LDL and HDL were significantly defferences(P<0.05) while total trigliceride of duck was similar in all treatments. The possible explanation is that antioxidants can inhibit the enzyme 3 hydroxy, 3 Methyl, Ko.A Gluteril-reductase, thus reduced the formation of

cholesterol (Agarwal and Rao, 2000), so that the levels of total cholesterol and LDL cholesterol decreased . It is similar to the cholesterol content in the blood which also declining. Decreasing in cholesterol levels followed by a decreased in levels of LDL and HDL.

Triglyceride levels in meat ducks offered treatment A was 117.70 mg/100g. Triglyceride levels are not affected by the purple sweet potatoof content, either fermented or not. This pattern was indicated by the levels of triglycerides in the blood of ducks thatof are not significantly different (P> 0.05). Meat lipid profiles are presented in Table 4.

Table 4
The Effect of fermented Purple Sweet Potato (*Ipomoea batatas* L) in the Ration on the Cholesterol Profile of Bali Ducks

Variable	Treatment							SEM[3)]
	A	B	C	D	E	F	G [1)]	
Total cholesterol (mg/100 g)	07.66[a 2)]	88.8[ab]	78.33[bc]	76.27[bc]	64.00 [cd]	58.69 [cd]	46.66[d]	6.52
HDL(mg/100g	45.53 [a]	43.56 [a]	38.80 [a]	28.80 [b]	18,86 [c]	18,47 [c]	15,01 [c]	3,17
LDL(mg/100g	35.60 [a]	20.20 [b]	18.67 [b]	18.29 [b]	14.46 [b]	13.68 [b]	12..37[b]	2.74
Trigliserida (mg/100g)	117. 67[ab]	125.2[ab]	105.00[ab]	136.83[ab]	153.37[a]	132.67[ab]	96.38[b]	15.97

[1)]Ration without the purple sweet potato (treatment A), ration containing 10%, 20%, and 30% purple sweet potato (treatment (B, C and D), ration containing 10%, 20%, and 30% fermented purple sweet potato (treatment E, F, and G).

[2)]Different superscripts in the same row are significantly different (P <0.05)

[3)]SEM: "*Standard Error of the treatment Means"*

Meat ducks LDL offered control ration ration A was 35.60 mg/100g. Duck meat on treatment C, D, E, F, and G meat had a lower LDL levels significantly (P <0.05) than that of treatment A. The lower LDL cholesterol levels in meat due to lower levels of LDL cholesterol in the blood. The formation of cholesterol in the liver is reduced due to the presence of antioxidants in the diet that inhibit the enzyme HMG-reductase converting Ko.A 3 Hydroxy, 3-Methyl Gluteryl Ko.A into mevalonic acid production is reduced, so as final result cholesterol will be reduced (Agarwal and Rao, 2000), and the effect on LDL cholesterol levels in the blood and the meat is reduced.

Conclusion

Based on the results of the experiment , it could be concluded that ducks offered of fermented purple sweet potato (*Ipomoea batatas* L) diet could increase antioxidant capacity and *superoxide dismutase* (SOD) and decreased *Malondialdehide* (MDA) of bali duck . When offered fermented purple sweet potato (*Ipomoea batatas* L) diet decreased the total cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) of bali duck.

ACKNOWLEDGEMENT

The author would like to thank to the Directorate General of Higher Education, Ministry of Education and Culture, Republic of Indonation through Udayana University which provided financial support for this work. Thanks are also due to the Faculty of Animal Husbandry, Udayana University and Faculty of Post Graduate Study who provided equipment and research facilities during this study.

REFERENCES

Agarwal, S dan Rao,A.V. 2000. Role of Antioxidant Lycopene in Cancer and Heart Disease. J.Coll. Nutr.: 19 (5) : 563 -9.

Cuchel, M. 1997. Lovastatin Decreases De Novo Cholesterol Synthesis and LDL Apo B-100 Production Rates in Combined-Hyperlipidemic Males. Journal of Arterioslerosis, and Vascular Biology, American Heart Association. 1910-1917.

Hillbom, 1999. Oxidant, Antioxsidant and Stroke. Fronties in Bioscience,4e August 15, 19999: 67 – 71.

Jawi I M., D. N Suprapta, dan A.A,Ngh. Subawa. 2008. Ubi jalar ungu menurunkan kadar MDA dalam darah dan hati mencit setelah aktivitas fisik maksimal. Jurnal Veteriner juni 2008, ISSN:1411-8327,Vol.9 No.2 : 65 – 72.

Kumalaningsih,S.2008. Antioksidan superokside dismutase (SOD) Antioxidant. centre.com.hhtp://antioxidant centre, com (10 Januari 2008).

Murray, R.K., D.L.Granner., V.W.Rodwell. 2009. Sintesis, Transpor, & Ekskresi Kolesterol. Biokimia Harper. Cetakan 1, Penerbit Buku Kedokteran, EGC,Jakarta. Halaman 239 – 249.

Okawa, M., J.Kinjo., T.Nohara and M.Ono.2001. DPPH(1.1 – Diphenyl -2-Picrylhydrozyl) RaDICAL Seavensing Activity of Flavonoid Obtained from Some Medicinal Plants, Biok. Pharm. Bull. 24 (10) : 1202 – 1205.

Prangdimurti, Endang; Muchtadi, Deddy; Astawan, Made; Zakarin, Fransisca R. 2006. Kapasitas Antioksidan dan Hipokolesterolemik Ekstrak Daun Suji. http://repository.ipb.ac.id/handle/123456789/42306

Setyawardani T., D. Ningsih., D.Fernando., dan Arcarwah. 2001. Pengaruh pemberian ekstrak buah nanas, dan pepaya tewrhadap kualitas daging itik petelur afkir. Buletin Peternakan, Ditewrbitkan oleh Fakultas Peternakan Univ. Gadjah Mada,Yogyakarta. ISSN. 0126-4400, Edisi Tambahan, Desember 2001

Scott M.L.,M.C.Neisheim and R.J.Young.1982. Nutrition of The Chicken. 2 nd Ed. Publishing by:M.L,Scott and Assoc. Ithaca,New York.

Steel R.G.D dan J.H.Torrie.1989. Prinsip dan Prosedur Statistika. suatu pendekatan biometrik. Penerbit PT Gramedia Pustaka Utama, Jakarta.

Sumardika ,IW. dan I M. Jawi.2011. Water extract of purple sweet potato leaves improved blood lipid profile and SOD content of rats with high cholesterol diet. Proceedings 3rd Intenational Conference on Biosciences and biotechnology. Maintaining world prosperity through biosciences, biotechnoloy and revegetation. Bali, september 21 st – 22nd, 2011..

Tillman,A.D.,H.Hartadi,R, Soedomo,P.Soeharto dan L.Soekanto.1998.Ilmu Makanan Ternak Dasar. Cetakan ke-6. Gadjah Mada University Press,Yogyakarta

Udin,S., I Kt.Lana., T.I.Putri., T.G.Oka Susila.1993. Pedoman Kerja Manual, Cholesterol . Laboratorium Nutrisi dan Makanan Ternak, Fakultas Peternakan, Universitas Udayana.

Wuryastuti. 1996. Pemeriksaan Kadar Malondialdehida (MDA) dengan methode Thiobarbituric acid (TBA). Laboratorium Gizi UGM Yogyakarta. .

Yadnya, TGB. and A.A.A.S. Trisnadewi, 2011. Improving the Nutrition of Purple Sweet Potato (*Ipomoea batatas* L) through Biofermentation of *Aspergillus niger* as Feed Substance Containing Antioxidants. Proceeding 3RD International Conference on Biosciences and Biotechnology. Maintaining World Prosperity Through Biosciences, Biotechnology, and Revegetation.Bali, September 21 ST – 22 ND ,2011, P. 378 – 383.

2

DAFTAR PUSTAKA

Aisjah,T; Rachmat Wiradimadja, dan Abun. 2007. Suplementasi Metionin dalam Ransum Berbasis Lokal terhadap Imbangan Protein pada Ayam Pedaging. Proceeding. seminar Nasional AINI VI. Kearifan Lokal dalam Penyediaan Serta Pengembangan Pakan dan Ternak di Era Globalisasi. Kerjasama Bagian Nutrisi dan Makanan Ternak, Fakultas Peternakan, Universitas Gadjah Mada Yogyakarta dengan

Anonymous. 2009. "Attirangga si Pacar Air".(online). Http://batakone.wordpress.com diakses 07 April 2010

Anonymous.2010a."Kolesterol".(0nline)http: //id.wikipedia.org diakses 10 April 2010.

Anonymous.2010b. "Penyebab Kolesterol Tinggi". (online) http:// Dunia-Ibu.org diakses 10 April 2010.

Anonymous.2010c."Flavonoid" .(online)http://en.wikipedia.org diakses 11 April 2010.

Alfaatth,Moh; Eko Widodo, dan M.Halim Natsir. 2008. Tingkat Penggunaan Tepung Limbah Ubi Jalar Ungu *(Ipomoea batatas* L) dalam Ransum terhadap Performan Produksi Ayam Pedaging. Jutusan Nutrisi Makanan Ternak-Fapet UB. File:///D:/ampas%ketela%20ungu.htm. Diakses 19/08/2010 21:12.

Alan,C.T., J.Elias., J.J.Kelley.,R.S.C. Lin and I.R.K. Robson. 1976. Influence of certain dietary fibers on serum and tissue cholesterol levels in rats. 1976.J.Nutr. 106: 118 -123.

Apriryantono,A; D.Fardiaz; Ni L.Puspitasari; Sedarnawati; dan S.Budiyanto.1989. Petunjuk Laboratorium Analisis Pangan. Departemen Pendidikan dan Kebudayaan , Direktorat Pendidikan Tinggi , Pusat Antar Universitas Pangan dan Gizi Institut Pertanian Bogor.

Association Of Official Analytical Chemist A.O.A.C).1980. Official Method of Analysis. 13 th. Ed. Washington.DC.

Bidura, I Gst.N.G.2007. Aplikasi produk bioteknologi pakan ternak. Penerbit Universitas Udayana

Buckle,K.A; R.A.Edward; G.H.Fleet and M.Wooton.1987. Ilmu Pangan terjemahan Hari Purnomo dan Adiono. Universitas Indonesia Press,Jakarta.

Budaarsa,K. 1997. Kajian penggunaan rumput laut dan sekam padi sebagai sumber serat dalam ransum untuk menurunkan lemak karkas dan kolesterol daging babi. Disertasi Program Pasca sarjana, Institut Pertanian Bogor, Bogor.

Bravo L, Abia R, Eastwood MA and Saura – Calixto F. 1994. Degradation of polyphenols (catechin and tannic acid) in the rat intestinal tract. Effect on colonic fermentation and faecal output. Bristish Journal of Nutrition 71,933-946.