Consumer preference on the meat of local male duck fed with additives liquid turmeric filtrate-loaded nanocapsule in ration

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Abstract— Consumer preference for duck meat product should be the primary consideration in production. The study aimed to investigate the effect of additional liquid turmeric filtrate (LTFN) as the phytobiotic in ration on consumer preference. The study was conducted in one-way completely randomized design. Sixty-three local male ducks aged 6-10 weeks were allotted to seven treatments, each with three repetitions to four ducks. The formulation of addition NKFCs was as follows: negative control / basal ration (BR) + LTFN 0% (P1), BR + LTFN 1% (P2), BR + LTFN 2% (P3), BR + LTFN 3% (P4), BR + LTFN 4% (P5), dan BR + LTFN 5% (P6), BR + LTFN 6% (P7). The variables of preference / organoleptic properties included color, aroma, texture, tenderness, flavor and palatability. The result of the study showed that the additional LTFN significantly affected ($P<0.05$) all the preference variables but did not significantly affected ($P>0.05$) the aroma of local male duck meat. In conclusion, 0-3% of LTFN in ration was the optimum dose to produce the quality duck meat preferred by the consumers.

Index Terms— nanocapsule, filtrate-turmeric, organoleptic, meat, local male duck

1 Introduction

MEAT demand of Indonesian population is met from broiler (56%), beef (17%), free-range chicken (10%) and others (17%). Duck meat only contributes approximately 38.840 tons or 1,32% of the total meat production in Indonesia [1]. Meat duck contains a higher protein (21,4%) compared to beef (18,7%), (14,8%) and pork (14,8%) [2]. The data show that the demand and production of duck meat are considerably low despite the potential duck meat as the source of animal protein. The contributing factors are the consumers being unfamiliar with duck meat and the tough texture, high fat content and the antibiotic residue in duck meat. Improving the quality and quantity of duck meat may lead to the increased consumption of duck meat. Duck culinary trend is increasing in modern era. Consumer has shifted priority from price to the quality of the product as antibiotic residue and the high LDL-cholesterol level have become the main consideration in meat consumption

Antibiotic residue in duck eggs are prevalent in Bali, West Nusa Tenggara and East Nusa Tenggara, Indonesia such as 0,3% penicillin, 0,35 tetracycline, 2,66 aminoglycosides and 0,89% macrolide. It is evident that antibiotics are still utilized in duck farming [3]. The sample of chicken thigh meat and liver from the livestock is potentially harmful for consumption because the antibiotic residue is up to 27,08% [4]. The use of 50-100 ppm oxytetracycline and amoxycycline as the growth promoters in broiler feed produced 28-63 ppm of residue (±50%) and 64,5 ppm in the excrete (3-6 weeks of feeding); however, the amount of residue would decline in conjuction with the dosage and time period [5]. The effect of antibiotic residue in feed may lead to digestive disorder, skin disorder, anaphyilaxis, hypersensitivity, carcinogenic, mutagenic, hepatotoxicity, teratogenic, reproduction disorder and allergy [6], [7], [8], [9]).

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Lipid/cholesterol content in meat with skin was relatively high in local poultry (duck). An extensive research has shown that *Low Density Lipoprotein cholesterol* / LDL-C is the cause of atherosclerosis, coronary heart disease, stroke, high blood pressure and hypercholesterolemia [10]. Lipid content in duck is 8,2% per 100 g, higher than that of broiler, i.e. 100g 11].

The controversial use of antibiotics and the high cholesterol content result in unsafe feed; therefore, it is important to research natural ingredients as the alternatives of antibiotics and to lower cholesterol. One of the potential herbal medicine in Indonesia is curcumin—an active ingredient of turmeric rhizome which functions as an antiviral, antibacterial, antifungus, antiprotozoal, antiinflammation, antioxidant, anticancer, hypolipidemia and hypocholesterolemic [12]. Turmeric extract for broiler feed has 46% digestibility (low availability) and 54% is excreted in the feces [13] because it does not dissolve in water with acid of neutral pH which contributes to the low absorbability [14]. Turmeric-loaded nanocapsule technology using cross-

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linked chitosan with sodium tripolyphosphate capsule (STTP) in the form of powder is evidenced to increase curcumin digestibility up to 70,64% [13]. Turmeric powder-loaded nanocapsule (ethanol extract) had been effectively applied to broiler, resulting in 0.4% level which significantly improves the performance of intestines, digestibility, production and carcass quality. In addition, the meat was free-antibiotic and rich in protein EPA/DHA fatty acid and mineral, but low abdominal fat, subcutaneous fat and cholesterol [13]. Nanocapsule described above could technically replace or even exceed the synthesized antibiotics because it improved the quality of meat. However, the economic application to broilers and other cattle is considerably low. Accordingly, a new technology attempts to develop liquid turmeric-loaded nanocapsule (water extract turmeric) which is cheaper and more effective. It is expected to replace synthetic antibiotics in broiler at 2% [15]. In 2018, liquid turmeric filtrate-loaded nanocapsule (LTFN) is developed using chitosan and STPP capsulation. LTFN is utilized to 5-10-week-old ducks to analyze the meat quality from consumers palatability perspective (organoleptic test). Different optimum levels of LTFN was used in duck pellet production as the alternative to synthetic antibiotic to obtain a higher quality and quantity of duck meat.

2 MATERIALS AND METHOD

2.1 Materials

Sixty-three male native Indonesian duck—Mojosari ducks—aged 5-10 weeks were utilized in the study. Battery cage was made of bamboo, measuring 1 m long, 0,5 m wide, and 1,5 m high (1 x 0,5 x 1,5), with feed and drink containers in each cage. The equipment for the study included sampling apparatus (pen and notepad, scale, marker, plastic bag) and organoleptic test apparatus (stove, cooking pot, plate, knife, colander, bowl, spoon, tray, Teflon, questioner and pen and notepad). In addition, thirty semi-trained panelists, a set of duck slaughter equipment and scale. Ohaus scale with 2610-gram capacity and 0.1-gram precision was used to weigh the sample. The ration ingredients and nutrition content are presented in Table 1.

2.2 Method

A one-way completely randomized design consisted of seven treatments and three replicates using three local male duck aged 6-10 weeks. The ducks were kept in the cage for four weeks and offered with ration supplemented with LTFN as follows: negative control/basal ration (BR) + 0%LTFN (P1), RB + 1%LTFN (P2), RB + 2% LTFN (P3), RB + 3%LTFN (P4), RB + 4%LTFN (P5), RB + 5% LTFN (P6) and RB + LTFN 6% (P7). Preference variables were measured based on the organoleptic properties which included colour, aroma, texture, tenderness, flavor and the overall palatability. Water was provided ad libitum. Duck slaughter was conducted on week 10 according to Islam Syariah (halal) by cutting the trachea oesophagus, vene and artery. Sharp knife was used to ensure that the artery was thoroughly cut. Ducks feathers were completely plucked to separate carcass from the non-carcass. The skinned breast meat was used for organoleptic test (flavor, texture, aroma, tenderness and consumer preference) according to the questioner.

TABLE 1.

COMPOSITION AND NUTRIENT CONTENT OF BASAL RATION WITHOUT SYNTHETIC ANTIBIOTICS SUPPLEMENT

Feed ingredients	Grower (6-10 week) (%)
Ground Yellow corn	60,00
Ricebran	15,00
Soybean meal/SBM 45	20,00
Fishmeal	3,00
Palm oil	1,00
Limestone	0,55
NaCl salt	0,15
Masamix **	0,30
Total	100,00
Nutrient content*	
Crude protein (%)	17,54
ME (kcal/kg)	3094,37
Crude fat (%)	3,78
Crude fibre (%)	3,49
Calcium (%)	1,13
Available phosphor (%)	0,16
Lysine (%)	1,05
Methionine (%)	0,32

Note : Composition of masamix per kilogram : vit A 810000 IU, D3 212000 ICU, E 1,8 g. K3 0,8 g, B1 0,112 g, B2 0,288 g, B6 0,3 g, B12 0,0036 g, Co 0,028 g, Cu 0,5 g, Fe 6,0 g, Mn 6 g; Iod 0,1, Zn 5 g. Se 0,025 g, DL-Met 212,5 g, L-Lys 31 g, As. Folat 0,11 g, As panthotennat 0,54 g, Niacin (vit B3) 2,16 G, CholinC160% 75 g.

Preference test of organoleptic test was conducted using the scoring method by 30 semi-trained panelists aged 20-30 years old. Each panelist received meat sample from all treatments, a 300ml-mineral water bottle and a questioner sheet. Sensoric properties test used breast meat where *Pectoralis superfisialis* muscle was located. Breast meat was boiled and sliced in the same shape and size. Panelists scored the meat according to the guideline. The observed variables were colour, aroma, texture, tenderness, flavor and palatability [16]. Data were subject to analysis of variance. When significant difference occurred, *Duncan's New Multiple Range Test* was conducted [17].

3 RESULT AND DISCUSSION

Preference/palatability assessment or organoleptic test on the boiled duck meat was performed using comparison test. The sensoric properties/the quality of the boiled meat was the quality parameter which consisted of the aroma, colour, texture, tenderness, flavor and palatability of the boiled meat that were subjectively assessed by the panelists. The result of the organoleptic test is presented in Table 2.

3.1. Meat Color

Meat color was one of the primary sensoric properties. The contributing factors to meat color are the type of myoglobin molecules and the chemical, physical and other condition of the meat. The primary pigment of the cooked meat is hlobin hemichromogen (brown). Meat color was measured according to the panelist' observation rather than the Lovibond. The result showed that the score of duck meat fed with LTFN was

TABLE 2
RESULT OF ORGANOLEPTIC TEST ON BOILED MEAT OF LOCAL MALE DUCK

Treatments (additional turmeric-loaded nanocapsule in ration)	**Mean**					
	Color*	**Aroma^{ns}**	**Texture***	**Tenderness****	**Flavor ***	**Palatability***
P1 (BR+LTNF 0%)	$3,97^{b}$	$3,13^{a}$	$2,43^{a}$	$2,00^{a}$	$2,50^{a}$	$2,23^{a}$
P2 (BR+LTNF 1%)	$3,17^{a}$	$3,10^{a}$	$2,90^{ab}$	$2,60^{bc}$	$2,97^{ab}$	$2,90^{b}$
P3 (BR+LTNF 2%)	$3,27^{a}$	$3,30^{a}$	$2,80^{ab}$	$2,40^{ab}$	$2,87^{ab}$	$2,93^{b}$
P4 (BR+LTNF 3%)	$3,30^{a}$	$3,20^{a}$	$2,87^{ab}$	$2,40^{bc}$	$2,93^{ab}$	$2,53^{ab}$
P5 (BR+LTNF 4%)	$3,00^{a}$	$3,23^{a}$	$3,07^{b}$	$2,80^{bc}$	$2,60^{ab}$	$2,97^{b}$
P6 (BR+LTNF 5%)	$3,27^{a}$	$3,43^{a}$	$3,17^{b}$	$3,07^{c}$	$3,13^{b}$	$3,03^{b}$
P7 (BR+LTNF 6%)	$4,07^{b}$	$3,43^{a}$	$3,20^{b}$	$3,73^{d}$	$2,83^{ab}$	$2,97^{b}$

Note : ns = non significant, *Values bearing different superscripts within column show significant difference (P<0,05), ,** Values bearing different superscript within columns showed highly significant difference (P<0,01).

significantly different (P<0,05), i.e. 3,9-4,0 with normal white to yellowish color because LTFN supplement did not affect myoglobine [18], [19], hemoglobin [20], and heme pigment which determined meat color. According to Soeparno [19], the contributing factors to meat color were feed, species, ordo, age, sex, stress factor (activity and types of muscle) pH, and oxygen. The present study explained that curcumin—the yellow pigment from turmeric—was rapidly metabolized in body and converted into the derivate; therefore, the original color (yellow) between P1 and P7 was significantly different (P<0.05) on the meat of duck fed with turmeric-loaded ration. Meat in P1 was normal white. Duck belongs to white meat group and therefore the white duck meat was preferable by the panelists. Nurwantoro and Mulyani [21] stated that the chromoprotein, hemoglobin, cytochrome, flavin and vitamin B12 was relatively small. Color properties did not affect nutritional value, but yellowish meat color tended to have low quality. Marbling fat did nt affect myoglobine and hemoglobin but the fat of fresh meat tends to appear yellow due to the accumulated karotenoid pigment in the tissues.

3.2. Meat Aroma

Aroma is a crucial quality property in organoleptic test of feedstuff because aroma significantly affects consumer's palatability on a product. Aroma gives an impression in an instant to the consumers. Assessment on aroma may be conducted from a distance or without sighting the product. The panelist gave an average score 3,1-3,4 for meat aroma (not putrid and less putrid) as presented in Table 3. Statistical evaluation indicated that feed additives/LTFN was not significantly different (P>0,05). It was assumed that the turmeric extrac (antioxidant) increased the nutrition absorability; therefore, it absorbs the putrid smell by capturing the free radicals and inhibiting the performance of peroxide enzyme which caused the putrid smell of the boiled duck meat. Hustiany [22] reported that the putrid smell of duck meat was the result of lipid oxidation and the main contributor to the decreasing meat quality. Volatile oil in turmeric can function as antimicrobial that eradicates the putrid smell in duck meat. It was in line with Agusta [23] that volatile oil could inhibit the growth of several pathogenic bacteria such as *Escherichia coli, Salmonella sp, Staphylococcus aureus, Klebsiella* dan *Pasteurella.* A small amount of feed/LTFN would be degraded in the digestive tract then absorbed in blood and carried to the whole body. Curcumin in the cell fluid was rapidly absorbed, metabolized and converted into compounds; accordingly, the original aroma of curcumin would disappear in meat, so the aroma of duck meat was not significantly different.

3.3. Meat Texture

Texture is the sensoric property related to the level of tenderness. The lowest mean value of the boiled duck eat was reached at 0% LTFN addition (P1) as shown in the soft texture, and the highest mean value was reached at 3,2 or 6% LTFN (P7) bearing coarse texture. In contrast, result of analysis of variance showed significant difference (P<0,05). The significantly different score of the texture indicated different fibre visuals. Turmeric extract in LTFN contains tannin, so the higher the LTFN dosage, the tougher the texture.

According to Warris [24], three main factors of meat texture were the length of sarcomere, the amount of connective tissue and crosslink, and the extent of proteolytic change during meat aging. The extent and amount of intramuscular fat (marbling) would tenderize the meat because fat is softer than muscle. The different meat texture was attributed to the age, activity, sex and types of feed [25].

3.5. Meat Tenderness

Tenderness is one important parameter to determine the quality of meat using organoleptic test. The higher LTFN level in ration, the lower the meat tenderness. Result of analysis of variance showed the significantly different effect of LTFN on meat tenderness (P<0,05). LTFN (curcumin) functioned as antimicrobial and increased the relaxation of the small intestines but not the protein or muscle structure. Volatile oil also increased body immune. There were more connective tissues than muscle and fat (cholesterol) so the meat tenderness ranged between semi-tough and tough. Soeparno [26] stated that three components of meat which affect the tenderness or toughness were connective tissues, muscle fibers and adipose tissue. According to Komariah *et al.*[27] tender meat is consumers' favorite.

One of the determining factors of meat palatability and preference is texture and tenderness. Tenderness varied among species and ordo, within species, carcass, between muscle and within muscle [26].

Connective tissue plays a main role in meat tenderness/toughness. However, meat tenderness is the result of a complex combination of different factors which could significantly decrease the palatability [28].

3.4. Meat Flavor

Flavor is the sensoric quality of meat related to the tasting sense or tongue. Some meats have a typical taste. Flavor is one of the consumers' concerns. The lowest mean value was at 0% LTFN (P1) as non-savoury, and the highest was at 5% LTFN (P6) as very non-savoury. Result of analysis of variance showed that the boiled duck meat significantly affected (P<0,05) the flavor. It affected the substance of volatile oil in meat. It was assumed that the additional turmeric resulted in the less savoury flavor, therefore, it significantly affected the meat flavor analyzed by the panelists. The flavor of duck meat without turmeric nanocapsule remained savoury.

Purbo [29] noted that dynamic of meat flavor was determined by the cooking process of meat marbling and the flavor precursor. Fat significantly affected meat flavor and had a specific taste. Meat with good fat would result in tasty and savoury flavor. [29]. The aroma and flavor of cooked meat were greatly determined by the precursor dissolved in water and fat and the release of volatile oil in meat [30]. Volatile is the smallest molecule resealed by food during heating, chewing and other process so it reacted with the receptore sense in mouth [31].

3.6. **Palatability**

Palatability is one of the organoleptic variables of meat sensoric properties. Result showed that the lowest texture score of boiled duck meat was at 2,2 turmeric-loaded nanocapsule level 0% (P1) with a very high palatability, and the highest texture score was at 3,0 turmeric-loaded nanocapsule at 5% (P6) with low palatability. Result of analysis of variance showed that boiled duck meat significantly affected (P<0,05) the palatability. It was assumedly due to the bitter substance in turmeric so the panelists preferred meat without turmeric additives. It identified that 0-3% LTFN could be utilized as the alternative of commercial ration which contained antibiotics and other chemicals that were not identified as growth promoter. Soeparno [19] stated that meat score was based on consumer acceptability. The panelists acceptability on duck meat was not affected by LTFN additives in feed. The satisfaction of meat consumers potentially depended on the physiological and sensoric respons among individuals [19]. It was in accordance with Ramayani [32] tha 5-15% turmeric extract could decrease the panelists palatability on the sensoric quality of male duck meat.

4 CONCLUSION

The study concluded that supplementing 0-3% of liquid turmeric filtrate-loaded nanocapsule (LTFN) in the ration did not decrease consumers' palatability/preference on duck meat.

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REFERENCES

[1] Anonim, 2015. *Statistik Peternakan dan Kesehatan Hewan*. Direktorat Jendral Peternakan dan Kesehatan Hewan Kementrian Pertanian RI : Jakarta.

[2] Srigandono, B. 2012. *Ilmu Unggas Air*. Gadjah Mada University Press. Yogyakarta.

[3] Dewi, A.A.S., N.P. Widdhiasmoro, I. Nurlatifah, N. Riti and D. Purwanti, 2014. Residu antibiotik pada pangan asal hewan, dampak dan upaya penanggulangannya. *Buletin Veteriner*, BBVet Denpasar, 36(85):1-12.

[4] Marlina, N., E. Zubaidah dan A. Sutrisno. 2015. Pengaruh pemberian antibiotika saat budidaya terhadap keberadaan residu pada daging dan hati ayam pedaging dari peternakan rakyat. *Jurnal Ilmu-ilmu Peternakan* 25(2):10-19.

[5] Wiyana A, Nasroedin, J.H.P. Sidadolog, 1999. The effect of oxytetracycline and amoxycillin as feed additives on performance , tissue and excreta residues of broiler. *Agrosains*, 12: 173-185.

[6] Nisha A.R. , 2008. Antibiotic Residues-A Global Health Hazard (Review). *Veterynary World*, Vol. 1 (12) : 375-377.

[7] Ruegg, P. L. 2013. *Antimicrobial residues and resistance: Understanding and managing drug usage on dairy farms.* University of WI, Dept. of Dairy Science, Madison.

[8] Seri, H.I. 2013. Introduction to veterinary drug residues: Hazards and risks. *Workshop of veterinary drug residues in food derived from animal*. 26-27th May 2013. Department of Animal Health and Surgery. College of veterinary Medicine. Sudan University of Science and Technology.

[9] Singh, S., Sanjay, S., Neelam, T., Nitesh, K., dan Ritu, P. 2014. Antibiotic residues: a global challenge. An International Journal of Pharmaceutical Science. *Pharma Science Monitor.* 5 (3):184-197.

[10] Istiqomah N., 2009. Pengaruh Minyak Atsiri Cabe Jawa (*Piper retrofractum* Val.) terhadap Jumlah Platelet Tikus Wistar yang Diberi Diet Kuning Telur. *Laporan Akhir Penelitian Karya Tulis Ilmiah*. Fakultas Kedokteran Universitas Diponegoro. Semarang.

[11] Srigandono, B. 1997. *Beternak Itik Pedaging*. Jakarta: Tribus Agriwidya.

[12] Araújo CC, and Leon LL., 2001. Biological activities of *Curcuma longa* L. *Mem Inst Oswaldo Cruz.* 2001 Jul; 96 (5): 723-8. http://www.ncbi.nlm.nih.gov/pubmed

[13] Sundari. 2014. Nanoenkapsulasi Ekstrak Kunyit dengan Kitosan dan Sodium-Tripolifosfat sebagai Aditif Pakan dalam Upaya Perbaikan Kecernaan, Kinerja, dan Kualitas Daging Ayam Broiler. *Disertasi* Program Pasca Sarjana. Fakultas Peternakan, Universitas Gadjah Mada, Yogyakarta. (tidak diterbitkan)

[14] Maiti, K., K. Mukherjee, A. Gantait, B.P. Saha, P.K. Mukherjee. 2007. Kurkumin phospholipid complex: Preparation, therapeutic, evaluation and pharmacokinetic studi in rats. *Int J Pharm,*. 330 (2007)155-163.

[15] Zuprizal, Tri Yuwanta, Supadmo, Andri Kusmayadi, Ari Kusuma Wati, Ronny Martien dan Sundari. 2015. Effect of liquid nanocapsule level on broiler performance and total cholesterol. *Ijps* 14(7):403-406

[16] Kartika, B., Pudji Hastuti dan Supraptono, 1998. *Pedoman Uji Inderawi Bahan Pangan*. Yogyakarta. UGM.

[17] Astuti, M. 2007. *Pengantar Ilmu Statistik untuk Peternakan dan Kesehatan Hewan*. Cetakan pertama. Penerbit Binasti. Bogor.

[18] Fanatico, A.C., P.B. Pillai, J.L. Emmert, and C.M. Owens. 2007. Meat quality of slow- and fastgrowing chicken genotypes fed low-nutrient or standard diets and raised indoors or with outdoor access. *Poultry Sci*. 86:2245-2255.

[19] Soeparno. 2009. *Ilmu dan teknologi daging*. Yogyakarta: Penerbit Gadjah Mada University Press.

[20] Chartrin, P.K. Me´teau, H. Juin, M.D. Bernadet, G. Guy, C. Larzul, H. Re´mignon, J. Mourot, M.J. Duclos, and E. Bae´za. 2006. Effects of intramuscular fat levels on sensoric characteristics of duck breast meat. *Poultry Sci*. 85: 914-922.

[21] Nurwantoro dan S. Mulyani. 2003. *Buku ajar, Dasar Teknologi Hasil Ternak*. Fak. Peternakan, UNDIP, Semarang.

[22] Hustiany, R. 2001. Identifikasi dan Karakteristik Komponen *Off-Odor* pada Daging Itik. *Tesis.* Sekolah Pascasarjana Institut Pertanian Bogor. Bogor. 78 hlm.

[23] Agusta, A. 2000. *Minyak Atsiri Tumbuhan Tropika Indonesia*. Bandung: ITB Press, hal 1-7.

[24] Warris, P.D. 2010. *Meat Science* : an Introductory Text.2ndSchool of Veterinary Science University of Bristol, CABI Publishing. Bristol UK, pp. 194-205.

[25] Susanti, T. dan L. H. Prasetyo. 2007. *Panduan karakterisasi ternak itik.* Pusat Penelitian dan Pengembangan Peternakan, Bogor.

[26] Soeparno. 2005. *Ilmu dan Teknologi Pengolahn Daging*. Cetakan Keempat. Gadjah Mada University Press. Yogyakarta.

[27] Komariah, S. Rahayu, dan Sarjito, 2009. Sifat Fisik Daging Sapi, Kerbau dan Domba pada Lama Postmortem yang Berbeda. *Buletin Peternakan* . Vol. 33(3) : 183-189.

[28] Abustam. E. 2012. *Ilmu Daging*. Masagena Press. Makassar.

[29] Purbo, M. 2014. Pembentukan Flavor Daging Unggas oleh Pemasakan dan Oksidasi Lipid. *Jurnal Wartazoa*. 24. (3): 109-118.

[30] Soeparno. 2015. *Ilmu dan Teknologi Daging* Edisi Kedua. Gadjah Mada University Press. Yogyakarta.

[31] Sams, A. R. 2001. *Poultry Meat Processing*. CRC Press, Washington D.C. Hal : 36.

[32] Ramayani, S. 2012. Pengaruh Pemberian Kunyit (Curcuma domestica) terhadap Kualitas Bakso Daging Sapi. *Skripsi.* Fakultas Pertanian Universitas Bengkulu.