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Research Paper

EVALUATION OF CHEMICAL COMPOSITION AND METHANE GAS (CH_4) PRODUCTION OF COMPLETE FEED SUPPLEMENTED BY FATTY ACID

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Abstract

The ruminant has a unique digestive system that allows them to have the ability to digest and to use energy from forage or feed material contained high-fibre via microbial fermentation, which is mainly indigestible by enzymes present in the ruminant. The contribution of ruminant fermented gases to the global production of greenhouse gases and the projected demand for ruminant products have led to the emergence of several studies on strategies to reduce CH_4 emissions from ruminants. Manipulation of animal feed by adding additives in forage can be an effort to reduce methane gas production in ruminants, one of which is the addition of fatty acids. Long-chain fatty acids, mainly unsaturated fatty acids (UFA), have a toxic effect on the methanogenic bacteria archaea in the rumen, leading to reduced CH_4 production. In this study, showed that the addition of fatty acids could affect CH_4 production. This study conducted experimentation of composing feedstuff based on seven (4) treatments. Details of the seven (4) treatments are as follows complete feed with the addition of 0% fatty acid, myristic acid (10%), lauric acid (10%), and palmitic acid (10%). This study's CH_4 gas production value ranged from 73,3% -78.6% (vol/vol of total gas). The formation of methane gas in the rumen affects the formation of the final fermentation product in the rumen where the feed components, especially crude fibre, contribute to the formation of CH_4 gas.

Key words: *fatty acid, chemical composition, CH_4 production, ruminant, complete feed*.

INTRODUCTION

Ruminants can utilize high-fibre source feed through rumen microbial fermentation and provide high-quality products, such as meat and milk, for human needs. However, based on previous research, rumen fermentation is associated with the formation of methane gas (CH_4), one of the potent greenhouse gases. Subsequently, it results in the loss of some of the food energy in livestock. According to [18], methane emissions per feed unit or methane conversion rate are substantial due to the low quality of the forage. The higher the quantity of low-quality feed, the higher the methane production. The low quality of the forage in Indonesia is generated by its fast growth, which results in rapid flowering and seeding. According to [9], degradation and fermentation of feed fibre components by rumen microbes and producing volatile fatty acids further form methane and carbon dioxide gas.

Manipulation of forage with the addition of additives is used to reduce methane gas production in ruminants, one of which is the addition of fatty acids. Long-chain fatty acids, notably unsaturated fatty acids (UFAs), have a toxic effect on the rumen, especially in the methanogenic bacteria archaea, which urges a reduction in CH_4 production [12]. Research by [2] reported that several lipid sources counting fat, sunflower oil, and whole sunflower seeds that mainly contain long-chain fatty acids have the potential to reduce CH_4 emissions by an average of 17% of cattle growth. Likewise, studies with unsaturated fatty acid (UFA) supplementation can reduce the production of CH_4 in vitro [25].

According to the European Pharmaceutical Students' Association (EPSA), palm oil contains myristic acid, lauric acid, and palmitic acid that can act as substances that can reduce methane gas production. The natural state. That occurs when grease is combined to feed, is that the oil coats the protozoa's body. Protozoa coated with oil cannot carry out the metabolic activity that generates Protozoa to perish in the rumen. It is consistent with research conducted by [20]. The addition of 7.5% of vegetable oil can reduce the number of protozoa by 23.95% and diminish the amount of methane gas production 18.51%. This causes environmentally sound technology to be crucial in the livestock industry. This goal is in line with the world's current focus on researching endeavours to reduce methane gas in the livestock industry.

MATERIALS AND METHODS

This study conducted experimentation of composing feedstuff based on seven (4) treatments. Details of the seven (4) treatments are as follows complete feed with the addition of 0% fatty acid, myristic acid (10%), lauric acid (10%), and palmitic acid (10%).

T0: Complete feed (without fatty Acid)

T1: Complete feed + Myristic acid (10% DM)

T2: Complete feed + Lauric acid (10% DM)

T3: Complete feed + Palmiac acid (10% DM)

The variables used in this study were the analysis of nutrient content, namely dry matter, organic matter, crude protein, extract ether, crude fibre and CH_4 production.

RESULTS

In this research, a complete feed has consisted of wheat pollard, DDGS, copra meal, coconut cake, molasses, minerals, vitamins, and corn sugar.

Table 1. Complete Feed Composition

No	Feedstuff	DM	OM	CP	EE	CF
			% DM			
1	Concentrate	89,79	90,45	21,89	3,99	10,90
2	Corn stover	18,30	83,74	10,69	3,15	36,20

Note: - Results of analysis at the Laboratory of Animal Nutrition, Faculty of Animal Science, Universitas Brawijaya (2020)
- * Based on 100% DM

Table 2. Nutrient Content of Complete Feed

Treatments	Nutrient Content			
	DM (%)	OM	CP	EE
		(%DM)		
T0	92,56	86,42	14,88	3,17
T1	92,55	86,67	14,84	5,02
T2	92,90	86,76	14,98	4,78
T3	92,42	86,44	14,64	4,88

In this study, the complete feed was prepared with a balance of 60%: 40% for forage and concentrate.

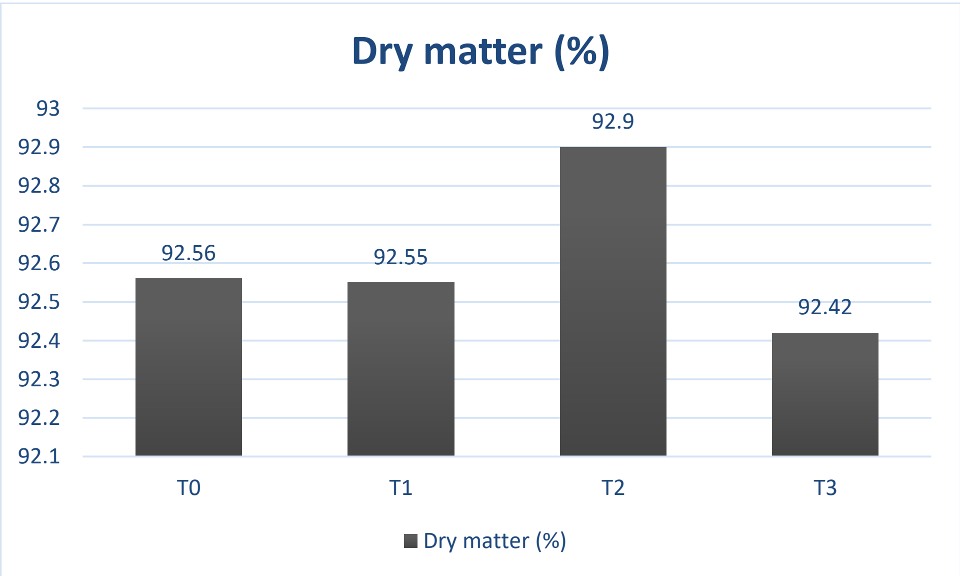

Figure 1. Dry Matter Content of Complete Feed

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This study's dry matter content was T0 92.56%, T1 92.55%, T2 92.90% and T3 92.42%. The dry matter content of T2 was higher than that of T0, T1 and T3.

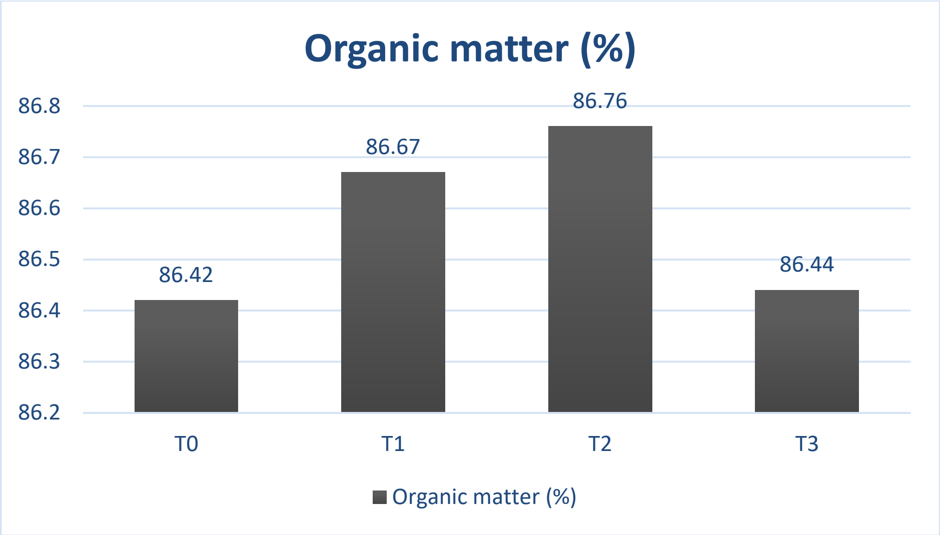

Figure 2. Organic Matter Content of Complete Feed

The organic matter content in this study was T0 86.42%, T1 86.67%, T2 86.76%, and T3 86.44. In this study, the average organic matter content was 86.57%.

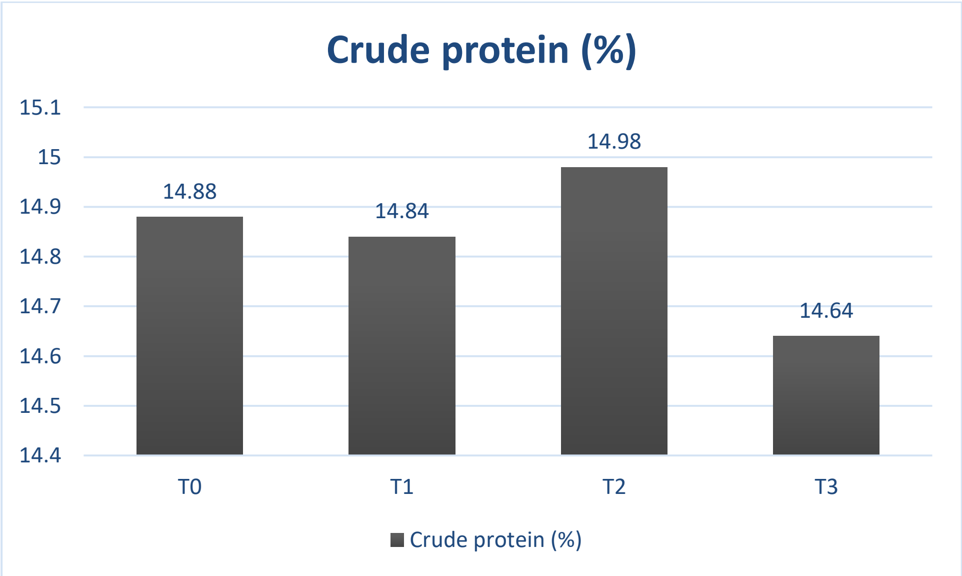

Figure 3. Crude Protein Content of Complete Feed

The crude protein content in this study was T0 14.88%, T1 14.84%, T2 14.13%, and T3 14.64%, this shows that the crude protein content in this study is isoprotein.

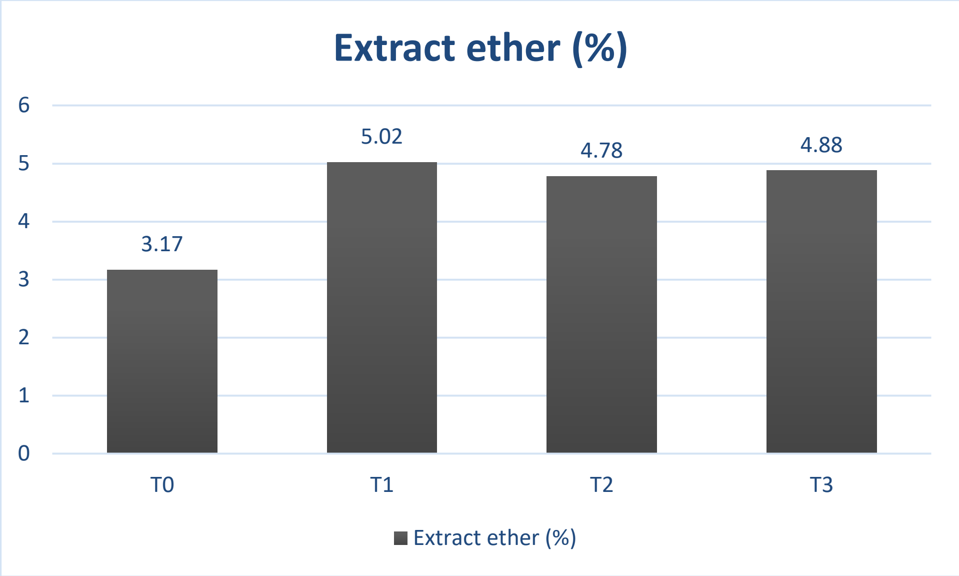

Figure 4. Extraxt Ether Content of Complete Feed

The extract ether content in this study was T0 3.17%, T1 5.02%, T2 4.78%, and T3 4.88%.

In this study, CH_4 gas production produced during the study is presented in the following table:

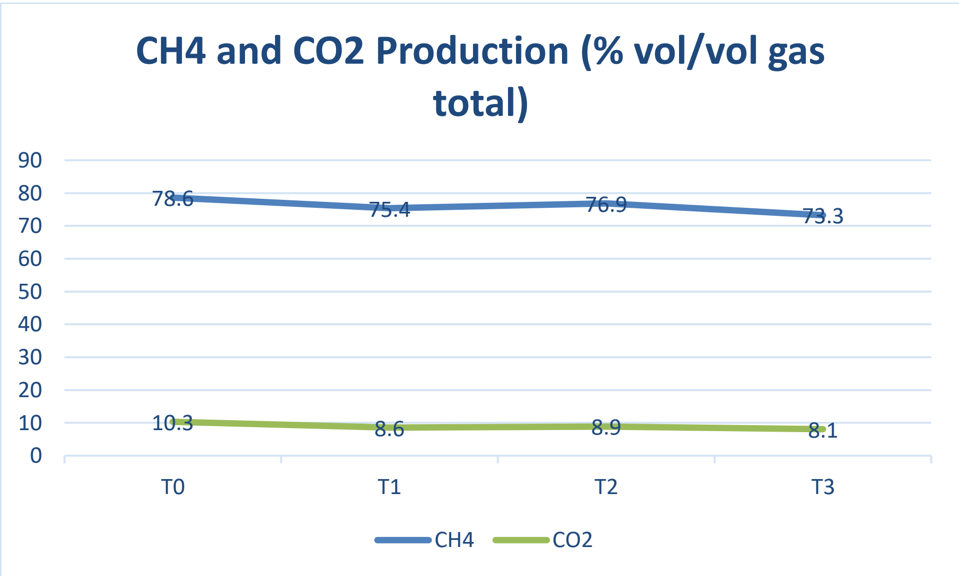

Figure 5. CH_4 and CO_2 Production

DISCUSSION

The dry matter content in this study is higher than [14]. The dry matter content in [14] is a complete feed with white kabesak leaf supplementation (Acacia leucophloea Raxb) with dry elements content at T0 of 89.8%, T1 89.9%, T2 89.8%, T3 89.9%, and T4 90.1

%. The difference in dry matter content amidst the research was lead by the feed sources used and the ingredients for the complete feed that consisted of protein and energy sources.

The organic material contained in this study was lower than that of [11]. In this study, the organic material content of the treated feed was about 86,42% and 86,76%, lower than the research of [14] that the content of complete feed organic matter in the treatment of T0 87.9%, T1 87.9%, T2 88.2%, T3 88.5%, and T4 88.5%.

In this study, the average aggregate crude protein content is 14.59%. Due to differences in the constituent materials used in the complete feed, the complete feed content was varied. This research surpassed [11], which had a crude protein content of 11.76%. The complete feed was amalgamated to be homogeneous through a physical treatment process and supplementation packaged in a specific form to provide adequate livestock and facilitate storage. The ratio of forage and concentrate used was 60%: 40%.

This study's crude protein content was T0 14.88%, T1 14.84%, T2 14.13%, and T3 14.64% respectively. This CP indicates that the crude protein content in this study is isoprotein. Differences in CP content due to differences in forage and concentrate. Differences in forage and concentrate can lead to differences in the nutrient content of nutrients.

The extract ether in this study was T0 3.17%, T1 5.02%, T2 4.78%, and T3 4.88%. Extract ethe content in this study tends to increase along with the increase in the addition of fatty acid components as a mitigating agent. Fatty acids are often found in various forms, particularly saturated fatty acids, unsaturated fatty acids, single-chain, or branched [24]. Recent advances in lipid metabolism processes have focused primarily on physicochemical manipulations. It aims to control the anti-microbial effect so that fat can be supplemented to livestock without disturbance of rumen fermentation and digestion.

Type of feed is one of the factors that influence methane gas (CH_4) production. Forage is a feed source that produces a higher CH_4 gas production than low fibre feed. According to [9], the type of feed consumed by livestock, especially organic matter and fibre, affects methane gas production. The higher the crude fibre content, the greater the methane gas produced. The fibre content influences CH_4 production produced by livestock in the feed it consumes. The increase in crude fibre consumption is associated with an increase in CH_4 production [19].

Methane and carbon dioxide gas production are reported as a percentage of the gas produced compared to the total gas in vitro. This study's value of CH_4 gas production ranged from 73.3 % -78.6% (vol/vol of total gas). CO_2 is a gas produced during fermentation in the rumen [4] Figure 1 shows the relationship between total gas production and methane production with a value of r^2 = 0.88 and carbon dioxide with a value of r^2 = 0.86. Methane gas formation in the rumen occurs by reducing CO_2 by H_2, catalyzed by enzymes produced by methanogenic bacteria [23]. The production rates of CH_4 and CO_2 are almost the same because they are the main product of microbes' fermentation process in the rumen [4]. Methanogenesis is a mechanism by the rumen to avoid hydrogen accumulation. Free hydrogen inhibits dehydrogenase and affects the fermentation process. The utilization of hydrogen and CO_2 to produce CH_4 is particularly important for the methanogenesis Archaea bacteria [17]. In principle, the formation of methane gas in the rumen occurs by reducing CO_2 by H_2, catalyzed by enzymes produced by methanogenic bacteria. The formation of methane gas in the rumen affects the formation of fermentation end products in the rumen, especially the number of moles of ATP, which affects the efficiency of rumen microbial production [23]. According to [16], components of feed, especially fibre and feed protein, contribute to gas production during the fermentation process. [23] stated that the content of organic matter, the content of fibre components, the value of degradability by microbes affects the methane gas produced.

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REFERENCES

[1] AOAC. 1995. Official Methods of Analysis. Washington: Association of Official Analytical Chemists.

[2] Beauchemin KA, McGinn SM, Petit H. 2007. Methane abatementstrategies for cattle: lipid supplementation of diets. Canadian Journalof Animal Science 87, 431–440.

[3] Božic A.K. Bozic, R.C. Anderson, G.E. Carstens, S.C. Ricke, T.R. Callaway, M.T. Yokoyama, J.K. Wang, D.J. Nisbet. 2009. Effects of methane-inhibitors nitrate, nitroethane, lauric acid, Lauricidin, and the Hawaiian marine algae Chaetoceros on ruminal fermentation in vitro. Bioresour. Technol., 100 (2009), pp. 4017-4025.

[4] Czerkawski, J.W. 1986. An introduction to rumen studies. Pergamon Press Ltd. Oxford, United Kingdom. pp. 1 - 236.

[5] Chuzaemi, S. 2002. Arah dan Sasaran Penelitian Nutrisi Sapi Potong di Indonesia. Makalah Dalam Workshop Sapi Potong. Pusat Penelitian dan Pengembangan Peternakan Bogor dan Lokal Penelitian Sapi Potong, Malang 11-12 April 2002.

[6] Faciola A. P., and G. A. Broderick. 2015. Effects of feeding lauric acid or coconut oil on ruminal protozoa numbers, fermentation pattern, digestion, omasal nutrient flow, and milk production in dairy cows. J Dairy Sci. 97:5088–5100.

[7] FAO. 2016. The State of Food and Agriculture. http://www.fao.org/3/a-i6030e.pdf

[8] Forster, P., Ramaswamy, V., Artaxo, P., Berntsen, T., Betts, R., Fahey, D.W., Haywood, J., Lean, J., Lowe, D.C., Myhre, G., Nganga, J., Prinn, R., Raga, G., Schulz, M. and van Dorland, R. (2007) 'Changes in atmospheric constituents and in radiative forcing', in Climate Change: The Physical Science Basis. Contribution of Working Group i to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (Eds.): Cambridge University Press, Cambridge, UK.

[9] Haryanto, B. 2009. Perkembangan penelitian nutrisi ruminansia. Wartazoa. 22: 169-177.

[10] Hwang IH, Kim HD, Shim SS, Lee SS, Ha JK (2001) Effect of unsaturated fatty acids on cellulose degradation and fermentation characteristics by mixed ruminal microbes. *Asian Austral J Anim Sci* 14:501–506.

[11] Gustiani, E dan Permadi, K. 2015. Study on Productivity of PO Cattle Provided by Complete Feed Containing Fermented Corn-Cobs in Majalengka District, West Java. Jurnal Peternakan Indonesia: Vol 17 (1).

[12] Kim CH, Lee SJ, Ha JK, Kim WY, Lee SS (2008) Effects of emulsified octadecanic acids on gas production and cellulolysis by the rumen anaerobic fungus, *Piromyces communis M014*. *Anaerobe* 14:19–28.

[13] Kurniawati, A. 2007. Teknik produksi gas in-vitro untuk evaluasi pakan ternak : volume produksi gas & kecernaan bahan pakan. Jurnal Ilmiah Aplikasi Isotop & Radiasi, 3(1), 40–49. https://doi.org/10.17146/JAIR.2007.3 .1.552.

[14] Lawa, EDW., Marjuki, Hartutik, and Chuzaemi. 2017. Effect of white kabesak (Acacia leucophloea Roxb) leaves level in the diet on feed intake and body weight

gain of Kacang goat.https://www.neliti.com/publications/222806/effect-of-white-kabesak-acacia-leucophloea- roxb-leaves-level-in-the-diet-on-feed

[15] Lovett D. K., Stack L.J., Lovell J., Callan B., Flynn B., Hawkins and O'Mara F.P. 2005. Manipulating enteric methane emissions and animal performance of latelactation dairy cows through concentrate supplementation at pasture. J. Dairy Sci. 88: 2836-2482

[16] Makkar, H. P. S. ; Francis, G. ; Becker, K., 2007. Bioactivity of phytochemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems. Animal, 1 (9): 1371-1391

[17] Martin, C., D. P. Morgavi, M. Doreau, and J. P. Jouany. 2006. Com-ment réduire la production de méthane chez les ruminants? Fourrages 187:283–300

[18] Odongo,NE., M.M. Or-Rashid, Kebreab, E., France, J., and McBride, B.W. 2007. Effect of Supplementing Myristic Acid in Dairy Cow Rations on Ruminal Methanogenesis and Fatty Acid Profile in Milk. J. Dairy Sci. 90:1851–1858 doi:10.3168/jds.2006-541.

[19] Philippe, F. X. & B. Nicks. 2014. Review on greenhouse gas emissions from pig houses : Production of carbon dioxide, methane and nitrous oxide by animals and manure. *Agri, Eco and Env* 199 e10-e25.

[20] Sitoresmi, P.D., Yusiati, L.M., dan Hartadi, H. 2009. Pengaruh Penambahan Minyak Kelapa, Minyak Biji Bunga Matahari, Dan Minyak Kelapa Sawit Terhadap Penurunan Produksi Metan Di Dalam Rumen Secara In Vitro. Buletin Peternakan Vol. 33(2): 96-105. Issn 0126-4400.

[21] Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and de Haan, C. (2006) Livestock's Long Shadow: Environmental Issues and Options, Rome, FAO-Food and Agriculture Organization of the United Nations, Copenhagen, Denmark.

[22] Sudarwati, H., Natsir, M. H., dan Nurgiartiningsih,V.M.A. 2018. Statistika Dan Rancangan Percobaan. Malang : UB press.

[23] Thalib A. 2008. Buah Lerak Mengurangi Emisi Gas Metan pada Hewan Ruminansia. Balai penalitian Ternak, Ciawi. Bogor.

[24] Warren, E., Sihota, N.J., Hostettler, F.D., Bekins, B.A., 2014. Comparison of surficial CO2 efflux to other measures of subsurface crude oil degradation. 275-284.

[25] Zhang G, Zhang J, Liu S, Ren J, Xu J, Zhang F . 2008. Methane in the Changjiang (Yangtze River) estuary and its adjacent marine area:riverine input, sediment release and atmospheric fluxes. Biogeochemistry 91: 71–84