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Review Article

The Oil Supplementation in Animal Feed Research Across Indonesia: Research Method to Data Analysis

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ABSTRACT

Oil supplementation has abundance of benefit for animals due to its fatty acid content. Otherwise, oil supplementation is being limited due to its effect on coating feed in digestive system and lead animal to hardly digest others nutrient. Moreover, with proper treatment, animal may gain immense benefit from it. Much previous research was conducted on giving oil supplementation yet there are many things remain to be addressed. This article investigated the developing of oil supplementation and finding a gap to be filled to encourage the potential of oil supplementation in Indonesia. There are many items shown on this article such as types of oil, variables, level of oil supplementation and protection used. The result showed that in vivo method used more frequently than in vitro method and Lemuru fish oil was used most rather than another type of oil with the level was on 2 and 3%. Types of animals mostly used is sheep with parameters examined was digestibility. Much previous research also showed that many oil supplementation used protection treatment such as saponification. Furthermore, this article showed that there is mostly parameter used and types of animals and variety of oil supplementation in Indonesia.

Keywords: biohydrogenation, oil supplementation, rumen fermentation, ruminant

INTRODUCTION

There is plenty research conducted in Indonesia to find the best types of oil and precisely treatments to be used for livestock. Indonesia has abundance of oil to be used as feed supplementation because the waste of oil industries in Indonesia is commonly not utilized by people. Thus, there are many reasons to use oil in feed supplementation such as highlighting their antimicrobial effects and ability to enhance nutrient digestibility while reducing methane production (Rofiq, 2022). Moreover, variety of livestock are vary used in much research. Finding the kind of oil and treatments based on animals' digestive system will make it more effective when it comes to be applied on livestock farm. The study found that the use of 0.2% fish oil in chicken rations significantly increased egg weight, yolk weight, eggshell thickness, haugh unit, and yolk index ($P<0.05$) compared to the control group without fish oil (Basudewa, 2022). But when it comes to pigs 0.5% soybean oil significantly reduced LDL levels while increasing HDL levels and 5% for Ongole crossbred (Basudewa, 2022). Thus, it showed that precise information on types of oil can be vary, it depends on animal digestive system. That is way this article strengthen the

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significant of many kind of oil and its affect on animal digestive system, in order to make the oil supplementation easier to be used by the farmer at livestock farm.

There are many limits applied on oil supplementation in feed, but the treatments already developed such as oil protection using saponification, microencapsulation and another types of oil combination with bioactive compounds. Lemuru fish oil supplementation on sheep conducted by combination with *Cinnamomum burnani* (Nalley, 2019) or with *Bawang Dayak* (Wati, 2019). Bioactive compound may protect the oil stronger by making protective structure and inhibiting the oil release to the surface (Ozyurt, 2022). Much research is trying to prove that using fish oil in feed may improve livestock's productivity with best way based on animals.

The parameters are significant factors to decide what treatment best and the level of oil used. Wati (2019) showed that Lemuru fish oil supplementation significantly improved the chemical quality of lamb meat, as all measured variables showed no significant differences across treatments yet significant improvements in the intake and digestibility of dry matter, organic matter, crude fiber, and crude protein (Hartati, 2015). Not only fish oil supplementation, essential oil supplementation also positively influenced the accumulation of beneficial fatty acids, including n-9 *monounsaturated fatty acids* and *polyunsaturated fatty acids* (PUFA), while inhibiting the biohydrogenation of n-6 and n-3 PUFA (Makmur, 2023). Furthermore, there are variety of parameters used to emphasize the best oil supplementation to improve quality of livestock's life and product. There is crucial necessity in reviewing trend of oil supplementation in Indonesia to make the novelty path of future research becoming sharper, more effective and efficient.

MATERIAL AND METHODS

Research Design

The study followed to the principle of content analysis which focused on finding from numerous studies that had been publish in scientific journals in Indonesia. The research method used was like those used by Fauzi and Pradipta (2020).

Data Source

The data were collected from the results of content analysis on animal science articles. All the articles were taken from animal science journals registered at Science and Technology Index (SINTA). SINTA is a platform to measure science and technology development which was designed and developed by Ministry of Research, Technology, and Higher Education of Indonesia. Furthermore, whole articles that reviewed critical thinking skill were collected from each of those journals. The articles under analysis in this study had been published online before January 2025. Published articles from various journals containing the keywords "oil supplementation, "feed" and "fatty acid" were collected to construct the database. A thorough evaluation of the full text articles was also performed to assess data sufficiency for database inclusion. To be included, an article needed to report at a minimum, the type of oil and animal, the parameters and the chemical composition of the ration used.

Of plenty of articles collected there are 41 articles that examine critical thinking. All of the articles were analyzed in this study. A total of 41 artivles, comprising 191 data points representing different oil supplementation in feed and its parameters, were integrated into database. The articles were screened based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis protocols.

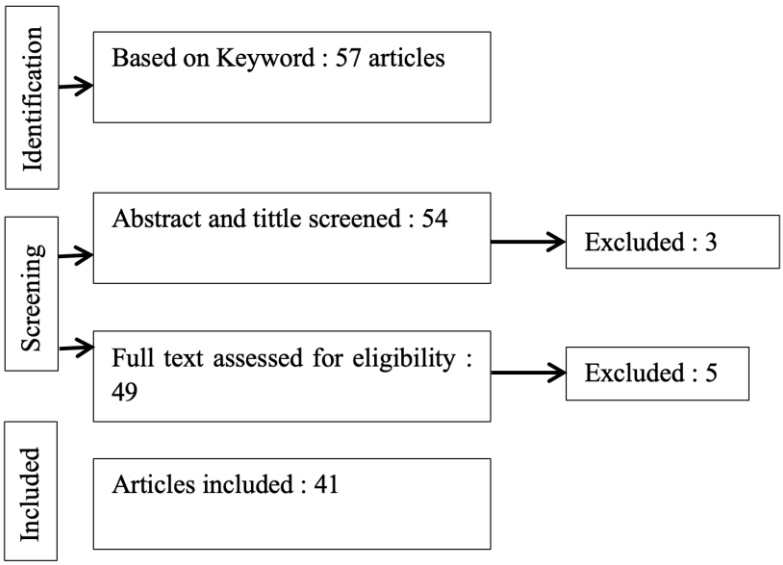


Figure 1. PRISMA Flow Chart

Research Instrument

The instrument used at this study contained related variables under observation (Table 1.). There were 6 aspects to review for content analysis in this study. Those aspects included (1) research method; (2) types of animals used; (3) types of specific animal used; (4) types of oil; (5) protection treatment; (6) parameter used; (7) level of oil supplementation.

Table 1. Treatment Feed Ingredients (%)

Aspects	Categories	
Research method	A.1-In vivo	
	A.2-In Vitro	
Types of animals used	B.1-Ruminant	
	B.2-Non ruminant	
Types of specific animal used	C.1-Broiler	C.4-Lamb
	C.2-Cow	C.5-Sheep
	C.3-Goat	C.6-Quail
Types of oil	D.1-Cat fish	D.4-Palm oil
	D.2-Lemuru	D.5-Tuna
	D.3-Olive oil	
Protection treatment	E.1-Saponification	E.3-Others
	E.2-Microencapsulation	
Parameter used	F.1-Body performance	F.5-Meat quality
	F.2-Digestibility	F.6-Rumen Fermentation
	F.3-Egg quality	F.7-Others
	F.4-Fatty acid	
Level of oil supplementation	G.1-2%	G.5-6%
	G.2-3%	G.6-8%
	G.3-4%	G.7-Others
	G.4-5%	

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Data Analysis

Each of articles were classified into specific category based on certain aspect that met the defined category. The decision was based on information that was shared by the authors in abstract, method, and discussion parts. Furthermore, the data had been collected were presented in a form of bar chart.

RESULTS AND DISCUSSION

Research Method

The research method used indicated the focus of a study. Based on figure 2, *in vivo* method constituted the most dominant method employed to investigate oil supplementation on animals. The researchers preferred in vivo method to conduct research on oil supplementation, rather than in vitro method. Such a condition was closely interlinked to the advantage of in vivo method to define phenomenon in detailed and comprehensively while it reflected on real circumstance of animal condition. For that reason, the lack of in vitro method existence has been a good chance for other researchers to make use of in vitro method to be focused on rumen fermentation parameters.

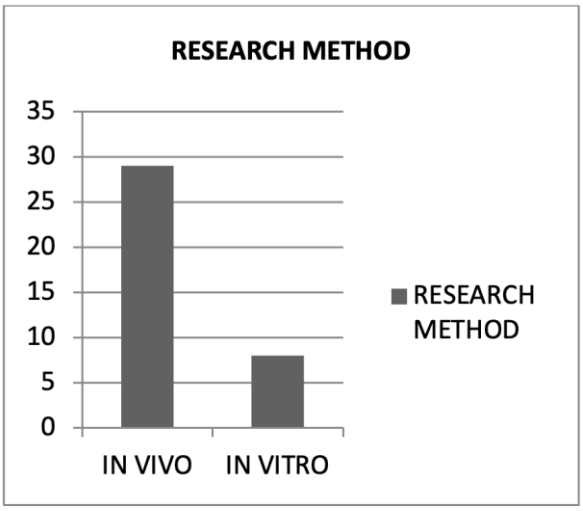


Figure 2. Research Method Used in Previous Research

Furthermore, the finding revealing the research method that had been chosen by most researchers. Based in figure 2, in vivo experimental design signified the most common experimental research toward oil supplementation on animal science while the researchers had to choose the best fitted their research concern. Yet, the in vivo method which was said as the most difficult design to be applied for animal research due to its unpredictable environment variables.

The most remarkable characteristic of in vivo method is the researchers are allowed to involve the more efficacy data than in vitro method by applying different diet directly to be consumed by animals. The researchers are allowed to sum up which treatment worked more significant to analyze feed in animals. Otherwise, on in vitro method, the researchers do not need to take into account unpredictable variables, which frequently be found on in vivo method, and more efficiency due to its low cost (Afriyani, 2015). On the other hand, in vitro method considers only limited aspects and providing partial information (Xu, 2021) regarding efficacy of oil supplementation.

From this current study showed that there are wide vary of parameters could be applied on in vivo method rather than in vitro method. From 41 selected articles, 29 of those have examined

digestibility, animal's product quality, fertility, body performance and many more. Yet, 8 of those articles using in vitro method mainly examined nutrient digestibility. The 4 of 41 articles neither stated in vivo or in vitro method because that research applied on food product from animal such as sausage which was conducted by Sujarwanta (2016).

Whereas in vivo method used animal subjects to provide most significant information. Any information generated in this study is supposed to enrich forthcoming research dealing with method used in oil supplementation in Indonesia.

Types of Animals Used

The empowerment of oil supplementation was aimed to improve animal's productivity. Based on the information regarding of research method, in vivo constituted the most used design the researchers preferred. In conducting research, the researchers needed research subject to examine their hypotheses. Based on figure 3, the most selected subject research was ruminant animal, consecutively followed by non-ruminant animals. It may cause by interconnected issues discussed over the growing concern toward impact of animal farming require a long-term global strategy to sustainable ruminant production (Paulina, 2016).

In ruminant, unsaturated fatty acid which be supplemented in diet has essential role to enhance human health through ruminant product such as meat and milk. Nevertheless, has abundance advantages, oil supplementation is inhibited for ruminant due to its negative effect on microbe's rumen (Oematan, 2023). The researchers conducted research to cope with its circumstances and making solutive way for ruminant to consume oil supplementation more effectively. Despite modifying the biohydrogenation of unsaturated fatty acid profile, adding oil to the diet of ruminant is a novel strategy to improve ruminant's product quality (Khattab, 2024). Because of that issue, ruminant is more frequently chosen as subject research in oil supplementation research.

Non ruminant as subject research is chosen due to the oil supplementation effect on non-ruminant's product such as egg quality and other parameters. The trend is not as high as ruminant animal, yet oil supplementation research on non-ruminant animal is conducted for numerous selected topics. The selected topic lied on similar reason that all of the topics portray roles and effects of non-ruminant's products. Topic observed for non-ruminant to examine oil supplementation is limited regarding the interaction between oil and feed ingredient or other feed additives (Zeng, 2015).

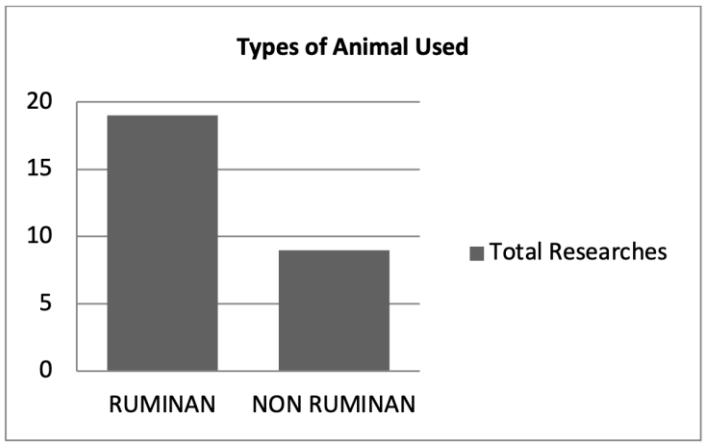


Figure 3. Types of Animals Used in Previous Research

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Types of Specific Animal Used

Giving specific information toward animal subject at testing the researchers' hypotheses or at identifying the significance or specific condition upon any parameter under investigation is needed. Based on figure 4, sheep constituted the most used animals in the research about oil supplementation. The sheep have been grown in all Indonesia island, especially in Java Island (Dewi, 2022). The finding of this current study informed that most researchers preferred parameters to be examined on ruminant, specifically sheep. There are six animals used from previous study on oil supplementation research, yet 4 of 6 are ruminant animals. This finding indicates that there is trend where research is more attracted on sheep, cow, lamb and goat parameters to be examined than broiler chicken and quail.

Dewi (2022) conducted research on sheep for parameters such as digestibility, yet Riyanto (2019) examined sheep meat quality to evaluate effectiveness of oil supplementation. Most articles do not stated strain of sheep used in previous study, only 3 publication stated strain of sheep which is Garut sheep (Sitaresmi, 2023) and thin tailed sheep (Setyaningrum, 2015) & (Dewi, 2021). Second ruminant mentioned in finding is beef cattle. There are vary of beef cattle used in previous publication such as Ongole crossbred (Purwati, 2016), Bali beef cattle (Hartati, 2015), and dairy cattle which was Friesian Holstein (Tasse, 2023). Despite similar digestive system among ruminant animals, the reason why beef cattle on that strain to be chosen on previous research because those animals commonly found in Indonesia.

Despite high number of publications on using ruminant animal as research subject, yet from this current study showed that quail has second place to be examined on oil supplementation research. It might be the quail's product such as egg already becoming the high demand in society. Oil supplementation, from previous publication, showed significant effect on quail's egg quality (Sany, 2015) & (Dewi, 2022). Thus, it made the researchers conducted experimental design to supplement oil in quail's diet.

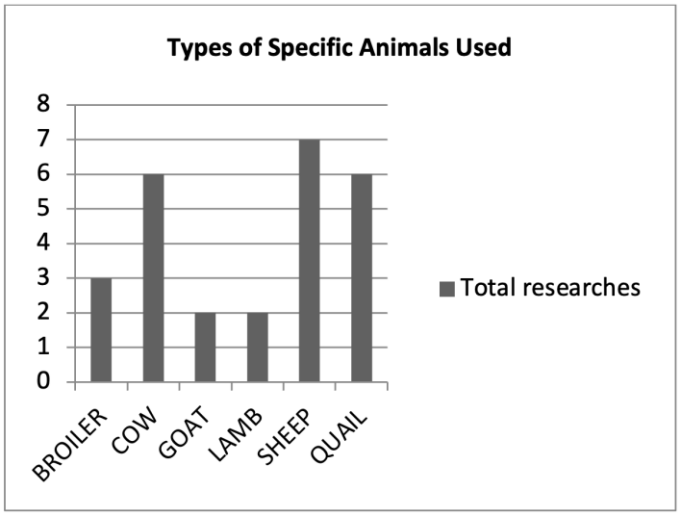


Figure 4. Types of Specific Animal Used in Previous Research

Types of Oil

Oil is main actor from this study thus comprehensive information toward types of oil used in researchers are needed. There are five predominant oils currently used to be supplemented on vary animals in Indonesia. Referring figure 5, it showed that Lemuru fish oil is significantly used to be supplemented in diet. There are 32 publications choosing Lemuru fish oil to be used both for

ruminant animals and non-ruminant animals. In Indonesia, Lemuru fish oil can be found in many places. Not only that, Lemuru fish oil which is gotten from waste of Lemuru industry is centrally located in Banyuwangi, Indonesia (Montesqrit, 2007). The availability in a big scale of Lemuru fish oil made research to choose Lemuru oil to be used in diet. Not only in research scale, when it applied for local farmer, it would also be affordable and accessible to be reached due to its abundance availability on its surrounding.

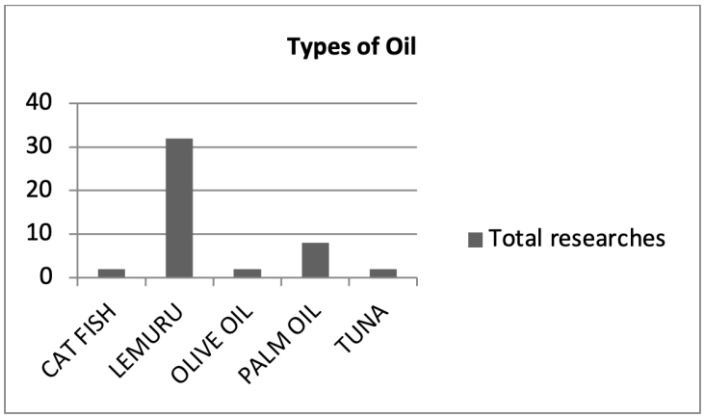


Figure 5. Types of Oil Used in Previous Research

In this finding, it is shown that not only the animal oil to be used in diet but also vegetable oil. Moreover, vegetable which is palm oil has second position to be used referring from the current study on this finding. Palm oil is also can be found in many places in Indonesia from big scale of industries to small scale of local farmer. Thus, palm oil is frequently used for researchers in diet (Sitaresmi, 2023). Nevertheless, from five oil which found through previous publication, three of those are animal oil and only two of them are vegetable oil. It showed that trend of oil supplementation research in Indonesia is preferred to choose animal oil to vegetable oil.

Putri, (2022) investigated effect on comparation between Lemuru fish oil and palm oil and analyze its effect on quail's egg. Result from that research showed that blended oil supplementation using Lemuru fish oil and palm oil resulted in higher n-3 fatty acid content (linolenic, EPA and DHA). Other types of oil found in this current study such as tuna oil, olive oil and catfish oil have similar number in previous publications.

Protection Treatments

Oil supplementation in diet has limited intake due to its negative effect in coating theory towards feed particles and microbes (Oematan, 2023). Recently, researchers were trying to increase the level of oil supplementation over the limit. On top of that, protection toward oil is necessity to make it less coating other nutrients so it cannot give negative effects for animal's digestion. There are vary protection on oil supplementation in diet such as saponification, and mixturing with bioactive compound treatments. Interestingly, figure 6 showed that mixture between oil and bioactive compound is frequently used rather than another protection treatments. There are many types of bioactive compound used such as garlic and curcuma which is likely to be found in many places in Indonesia.

Protection treatments have high cost that make its technique is not accessible and affordable to be conducted. Otherwise, several previous publications from these findings showed that other protection treatment using specific technique such as saponification already used. Moreover,

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protection treatments are intended to protect the oil to be degraded by microbes in rumen (Gimenez, 2023). Furthermore, in poultry protection treatments help to make oil less oxidative and prolong the lifesheld (Montesqrit, 2007).

Nevertheless, mixture between oil and other bioactive compound is predominantly studied in previous publication to see how oil interacts with those compounds to be able to create matrix structure toward the oil. Despite those treatments have different technique, yet those has similar purpose which is to supplement oil in animal digestive system. Purwati (2016) showed that Lemuru fish oil and palm oil supplementation using saponification treatment do not disturb nutrient digestibility.

Oil combined with other compounds has been examined in many articles. Mostly, accessible bioactive sources are chosen such as *cinnamon burmanni* (Wibowo, 2024), Dayak onion (Haerul, 2024), noni fruit (El-Azka, 2024), and sweet potato leaves (Paembonan, 2016). Bioactive compound which gotten from *Eleutherine palmifolia* (Bawang dayak) contain flavonoids, alkaloids, tannins, steroids, and triterpenoids which have antioxidant activity (Zakiyatulyaqin, 2020). Choosing bioactive compound from vary plants which commonly classified as phytobiotics (Haerul, 2024) can prevent the oxidation of unsaturated fatty acid to produce healthy fatty acid composition in animal's body.

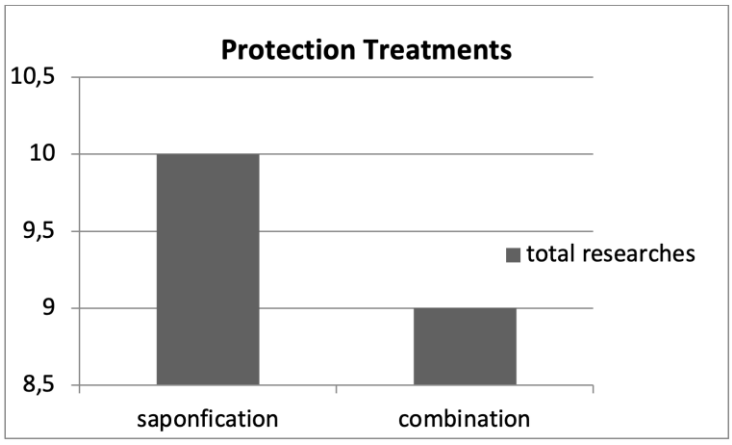


Figure 6. Protection Treatments Used in Previous Research

Not only bioactive compound from plants, one of articles stated that combine fish oil with substances such as Zinc mineral (Hartati, 2015) could be applied. Furthermore, that study stated that using mineral combined with fish oil resulted in increased intake and nutrient digestibility. From this finding, it showed that protection treatment is applied at high level of fish oil above 5% in diet. Combination Lemuru fish oil with formalaldehyde (Riyanto, 2015) & (Riyanto, 2019) is applied for beef cattle only. Though some publication stated that combining fish oil with another substance yet the most research preferred saponification to be used due to its effective role to protect unsaturated fatty acid more than other treatments.

Parameter Used

Parameter examined in this study are vary due to its animal used. Since ruminant animals are frequently used as research subjects, the parameters used in this study are dominated by fermentation characteristic in rumen. Nutrient digestibility has highest number to be examined the oil supplementation from the previous publication. Nevertheless, there is one articles (Sany, 2015) from those who stated to examine digestibility in quails by using 4% of Lemuru fish oil.

Parameters chose would be based on types of animals used, yet from figure 7 showed that digestibility is the most parameter to be examined by researchers toward oil supplementation. On top of that digestibility tends to enhance daily weight gain (Dewi, 2021). Comparing with other articles, (Kustyorini, 2018) showed the highest digestibility by supplementing protected catfish oil which showed that the protected fish oil did not give any significant effect on nutrient digestibility. These findings are consistent with previous studies indicating that Lemuru fish oil supplementation significantly improves nutrient digestibility and rumen fluid fermentability (Montesqrit, 2023). Otherwise, characteristic rumen fermentation which is examined through these findings are pH, NH3, CH4, protozoa population and microbe protein synthesis. Rumen fermentation has similar amount of parameter examined in previous publication with others parameter which are liver histology (Mushawwir, 2020), sperm motility (Lawa (2021), Malik (2018), Fitriyah, (2017)), cholesterol levels (Kuswady, 2008) and hatchability (Putri, 2015).

Egg quality, fatty acid and meat quality have similar amount of publication. Egg quality stated to be examined for poultry, specifically quail (Sany, 2015) and broiler (Basudewa, 2022). Fatty acid is also examined for different level of fish oil such as 4% of Lemuru fish oil (Putri, 2022) and 10% of catfish oil (Dwijayanti, 2024). Types of fatty acid encompasses polyunsaturated fatty acid and monounsaturated fatty acid, including EPA and DHA. Meat quality parameters in previous publication (Setyaningrum, 2015) & (Yurleni, 2013) conducted on sheep with similar fish oil which was Lemuru fish oil. Moreover, body performance parameters were examined both for ruminant and poultry. Body performances which examined for ruminant were birth weight and daily weight gain (Riyanto, 2019). On the other hand, for poultry were feed intake, weight gain and feed efficiency (Sumadja, 2023), and feed conversion ratio (FCR) (Suci, 2022).

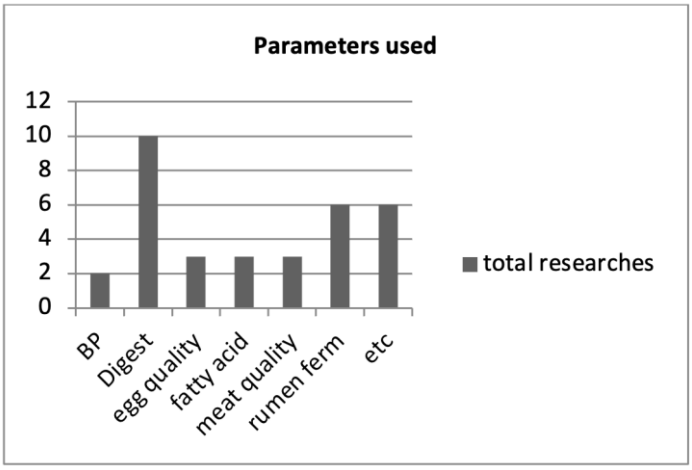


Figure 7. Parameters Used in Previous Research

Level of Oil Supplementation

Level of oil supplementation has limit to be given in diet. Many animals cannot be able to adopt the changes in higher level of oil in diet. Based on figure 7, it showed that there are 2 to 8% of oil supplementation recently conducted in Indonesia. On top of that, previous publications showed that there are many types of denomination used such as ppm (5), mg/kg (Wibowo, 2024), gr (Tasse, 2023), and g/kg ration (Yurleni, 2013). Figure 7 showed that other denominations were used more frequently than percentage denomination. From the lowest to the highest percentage, it reflected that researchers are trying to find fitted level of research concern. All of the level used

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of oil supplementation is required specific percentage through specific research concern to found precise level of oil based on animal and other substances added.

Figure 8 showed that 2% and 3% are most used than another level of oil supplementation. Kadarsih (2024) showed that supplementing 2% of olive oil resulted in saturated fatty acid decreased and increase in unsaturated fatty acids. The highest percentage of oil supplementation was 8% of Lemuru fish oil to examined rumen characteristic fermentation. Though Cahyo (2021) conducted research using 8% of fish oil supplementation, yet the best treatment was at 6% of fish oil. It was due to decreasing of nutrient digestibility after 8% of fish oil supplemented in diet.

From this finding showed that mostly, percentage above 5% was applied for ruminant animal and under 5% was applied for poultry. Only one articles (Fitriyah, 2017) conducted research to use 6% of blended oil such as palm oil and Lemuru fish oil to quails. Poultry is more responsive to the higher level of oil supplementation because it can slow down the rate of feed passage through digestive tract (Mateos and Sell, 1981), thus allowing more time for better digestion and absorption nutrients. This study explored the level of oil supplementation because determining the level of unsaturated fatty acids rich oil supplementation should be done carefully because the high level of oil supplementation in the animal diet could interfere feed digestion in animal's digestive system.

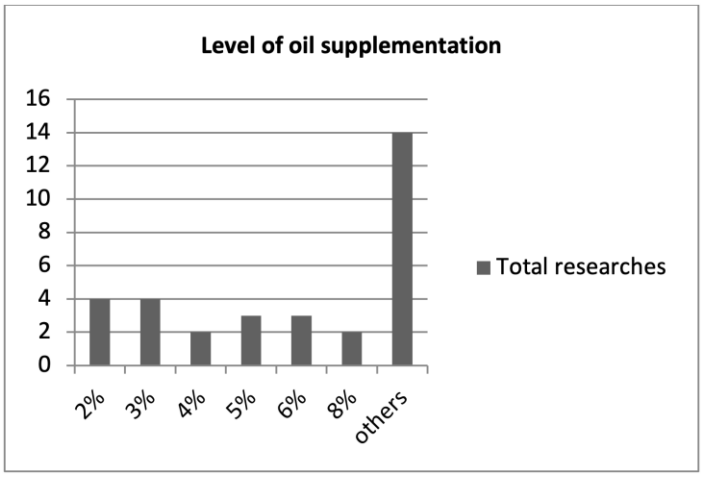


Figure 8. Percentage of Oil Supplementation in Previous Research

CONCLUSION

In vivo method used more frequently than in vitro method and Lemuru fish oil was used most rather than another type of oil with the level was on 2 and 3%. Types of animals mostly used is sheep with parameters examined was digestibility. Many previous research also showed that many oil supplementation used protection treatment such as saponification. Based on the outcomes of this article, oil supplementation demonstrated superior quality for livestock while still adhering to the established standards observed in the average values of all parameters. Recommendation for future research is broaden the article review to other journal platforms on international scale.

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