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# INNOVATION AND BIOTECHNOLOGY OF COFFEE PEEL WASTE USING DIFFERENT FERMENTERS AS ALTERNATIVE FEED ANIMAL

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**ABSTRACT**

The waste of peel coffee was potential to be used as feed animal because it is rich in nutritional quality for livestock needs. The Purpose of this study consist of: 1) Developing biotechnology and innovation of feed made from coffee peel waste as an alternative feed to support agro-industry, 2) Utilization of appropriate local raw material innovations as quality feed animal to increasing the nutritional value, growth and production of livestock; 3) Reduce the cost of forage substitution feed production using coffee rind as feed animal.Observation and collection of quality coffee peel waste, 2) Preparation and manufacture of fermenters, 3) Processing and manufacturing of fermented coffee peel waste feed additives, 4) Analysis of the nutritional quality of coffee peel waste using several fermenters. The results of the study using mixed coffee peel + local microrganism of the tempeh yeast is very significant and has a high nutrient content, much higher than other fermenters when viewed from dry matter 88.1%, crude protein 27.20%, crude fat 16.90%, Total Digestible Nutrient (TDN) 72.50%, and Crude Fiber decreased by 15.60%. The results of the study using coffee peel waste were alternative to the feed animal to support agro-industry it can be concluded fermenters using mixed coffee peel + local microorganism tempeh yeast have a high content when viewed from dry matter 88.1%, Crude Protein 27.20 %, Crude Fat 16.90%, TDN 72.50%, and Crude Fiber decreased by 15.60%.

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**Keywords:** Peel Coffee, Nutrition, Biotechnology, Fermenters.

## INTRODUCTION

The efforts to reduce production costs is to minimize the need for feed costs, so that farmers can benefit from livestock business. One way to meet the availability of feed ingredients in quality and quantity is to use and utilize agricultural waste (Huntington et al.,2018). The use of agricultural waste that is just thrown away, if studied has the potential to be used as animal feed because it is rich in nutritional quality for livestock needs, both for basic living needs and production (Huuskonen et al., 2014). Efforts to reduce 70% of production costs are to minimize the need for feed production costs, so that farmers can benefit from livestock business. One way to meet the availability of feed ingredients in quality and quantity is to utilize agricultural waste, one of which is coffee husk waste. The utilization of coffee peel waste, when examined from its nutritional quality, has the potential to be used as animal feed, because it is rich in nutrients so that it can meet basic living needs and livestock production (Indah et al., 2020).

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Coffee peel waste that is just thrown away can be used appropiatelly and optimally, so that cheap, quality feed is obtained, able to increased farmer income, support efforts to increase livestock population and productivity, and open up business opportunities for example processed into finished feed products, and reduce environmental pollution, caused by uncontrolled/abundant production of coffee rind waste will have the impact of becoming waste if it is not processed properly (Yulianto and Xuan, 2018).

The purpose of processing coffee peel waste for feed animal with fermentation biotechnology is as a complementary feed/feed additive that is used as a source of vitamins, minerals and antibiotics, as well as being able to improve nutritional quality (Yulianto et al., 2022). The function of the feed additive is to add vitamins, minerals and antibiotics to the ration, maintain and maintain the health of the livestock body against disease attacks and the effects of stress, stimulate body growth and increase appetite, and increase meat production (Yulianto et al., 2016). Improving community welfare is a development success for the government, which requires the expertise of regional managers, especially agricultural development planning in accordance with the potential of regional resources and the use of coffee peel wastebiotechnology as alternative feed animal to support a comprehensive agro-industry (Spore et al., 2019).

The purpose of processing coffee peel waste for feed animal with fermentation biotechnology is as a complementary feed additive that is used as a source of vitamins, minerals and antibiotics, as well as being able to improve nutritional quality (Yulianto et al., 2022). The function of the feed additive is to add needs vitamins, minerals and antibiotics to the ration maintain and health of the livestock, body against disease attacks and the effects of stress, stimulate body growth increase appetite, and increase meat production (Yulianto et al., 2016).

The strategy as a regulator and facilitator of regional development is to make policy coverage in planning activities in the agricultural sector, especially in processing agricultural waste into productive products, and being able to support the agricultural/livestock sector in a sustainable manner and intensive in processing agricultural waste (Ditjennak, 2010).

Generally, the purpose of this research is to obtain the benefits of biotechnology related to the utilization of coffee husk waste as an alternative animal feed to support the agro-industry (Yulianto et al., 2017). Based on the description of the background and the formulation of the research problem, the objectives of the research to be carried out are as follows: (1). To find the fermented coffee peel with high nutrition as a stakeholder for biotechnology innovation, the implications of biotechnology, and the efficiency of using animal feed formulas; (2). Finding local raw materials for coffee skin as animal feed in quality and quantity in increasing nutritional value, increasing digestibility, growth and livestock production; (3). Finding ration formulations to reduce feed costs by utilizing fermented feed additives and efficient use of feed; (4). Finding optimal research results in the use of fermenters in improving the nutritional quality of coffee skins as animal feed that is more innovative.

## LITERATURE REVIEW

### Coffee Peel Waste

Totally in this study used 200 kg dried of peel coffee. Chemically, it contains organic materials, namely oxygen (O), carbon (C), and hydrogen (H) which are formed in resin compounds (45%), hemi-cellulose (25%), ash (0.5%), cellulose (45%), and lignin (2%). In addition, the content of crushed coffee peel is 0.39% Mg; 0.53% Ca; 2.04% K; and 1.88% N (Pamungkas et. al., 2011).

One of the feed ingredients that have the potential for small and large ruminants is coffee peel waste. Proximate analysis results Cruch, (1989) states that the nutrients contained in the peel coffe of non-fermented is 8.49% Crude Protein (CP). However, coffee rind with wet conditions should not be given directly to livestock, because there is a high water content that can be easily damaged and is not liked by livestock. Non-fermented coffee rind is not only high in tannins and crude fiber, but also high in caffeine and lignin so

that if consumed in large quantities it will cause digestive disturbances in livestock. Fermentation technology is a method that can be used to minimize these factors by processing the skin of the coffee fruit before being given to livestock (Efendi et. al., 2014).

**Fermentation**

Fermentation is a feed change technology that can meet the nutritional content (protein and energy) and can reduce crude fiber, and is preferred by livestock because of the aromaticity of fermented products. Umiyasih and Anggraeny (2005) mentioned that by fermentation and reducing particles is believed to reduce crude fiber and TDN and increase protein content, so as to improve the nutritional quality of coffee husks. Fermentation has several benefits, namely increasing protein content, digestibility and palatability, and being able to reduce tannin and crude fiber content. One of the factors that influence consumption is the palatability of the type of feed given (livestock preference level). Cattle like fermented coffee pods, probably because cows the smell of fermented coffee (Efendi et. al., 2014).

**Local Microorganisms**

Local Microorganisms are materials that available in the environment and have the ability to break down organic matter because they contain degrading microorganisms (Yulianto et al., 2022). Local microorgnisme candidates that can be used include tempeh yeast and rumen contents, because these materials contain microorganisms, especially bacteria and fungi that can break down organic matter. Based on this potential, it is necessary to conduct basic research to determine the potential of tempeh yeast and rumen contents (Firdaus et. al., 2014).

## METHODS

This study used an experimental method of Completely Randomized Design (CRD) with 3 replications for each treatment (Stell and Torrie, 1985). The data obtained were analyzed using analysis of diversity, and differences between treatments were tested using Duncans Multiple Range Test (DMRT). Method of this study consist of some steps: Biotechnology procedure for collect coffee peel waste, fermentation process using a formulation consisting of rice washing water 3% of the total coffee peel waste material ± 960 kg = 28.8 Liters; palm sugar 2% = 19.2 kg; EM4 1% = 9.6 Liters; Minerals 3% = 28.8 kg; tempeh yeast dose of 3% = 28.8 kg; 5% tempeh yeast = 48 kg presented in **Table 1**. All ingredients are mixed until homogeneous then put into a plastic drum for 5 days for the fermentation process. Each inoculant substrate was added with a fermenter to test its activity and nutritional quality.

Collect data based on research variables using different fermenters. The variables studied consisted of Dry Matter (%), Crude Protein (%), Crude Fat (%), Crude Fiber (%), Extract Material Without Nitrogen (%), and Total Digestible Nutrient (%) of the nutritional quality of fermented coffee husk waste using several different fermenters:

1. Red Coffee Peel + Local Microorganisms Yakult (RCPMYa). Mixed Coffee Peel + Local Microorganisms Yakult (MCPMYa)
2. Red Coffee Peel + Local Microorganisms Yeast (RCPMYe). Mixed Coffee Peel + Local Microorganisms Yeast (MCPMYe)
3. Red Coffee Peel + Local Microorganisms Coffee (RCPMC). Mixed coffee peel + Local Microorganisms Coffee (MCPMC)
4. Red Control Coffee Peel (RCCP). Mix Control Coffee Peel (MCCP)

**Table 1. Number of Use of Composition Material for Feed Additive Peel Waste of Coffee fermented as feed cattle**

| Materials | Total Ingredients |
|---|---|
| Coffee skin waste | 960 kg |
| Rice wash 3% | 28,8 liter |
| Aren Sugar 2% | 19,2 kg |
| EM4 1% | 9,6 liter |
| Mineral 3% | 28,8 kg |
| Tempeh Yeast 3% | 28,8 kg |
| Tempeh Yeas 5% | 48 kg |
| Total | 270 kg |

## RESULTS AND DISCUSSION

### Dry Matter (%)

The dry matter content of several fermenters in fermented coffee husk waste was the lowest at 86.80% (control mixed coffee husk), and the highest was 89.60% (red coffee husk + local microorganism tempeh yeast). The results of the analysis of the diversity of several fermenters different little letters a, b and c were indicate significant different (P <0.01). Dry matter content of fermented coffee peel waste presented in **Figure 1**.

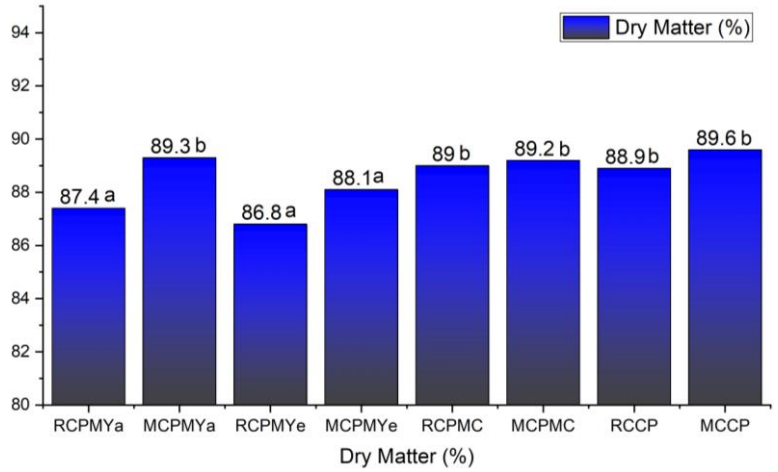


**Figure 1. Dry matter content of fermented coffee peel waste**

The high content of dry matter in the red coffee skin fermenter + local microorganism tempeh yeast is due to the fact that it has a fairly low crude fiber compared to other fermenters so that it is more easily degraded by microbes during the fermentation process. In accordance with the opinion that low crude fiber results in increased digestibility and dry matter coefficients, so that the fermenter is able to degrade plant cell wall components hemicellulose and lignin (Yulianto et al., 2017). Thus, the addition of red coffee skin fermenter + local microorganism tempeh yeast was able to increase the dry matter content by 89.60%, and decrease crude fiber by 11.40%.

### Crude Protein (%)

From the results of each fermenter treatment, the lowest crude protein value was 8.7% (coffee peel mixed with control), and the highest crude protein was 27.2 % (red coffee husk + tempe yeast). The results of the analysis diversity several fermenters different little letters a, b and c were indicate significant different (P <0.01) on the nutritional content of the crude protein of livestock rationson of each treatment of fermented coffee husk as feed animal, which can be seen in **Figure 2**.

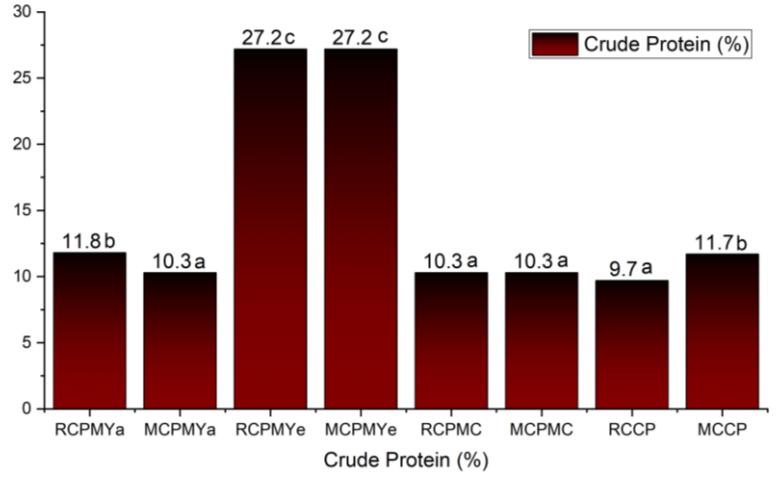


**Figure 2. Crude protein content of fermented coffee peel waste**

The high content crude protein of the RCPMYe were 27. 2% in the red coffee skin fermenter + local microorganism tempeh yeast is compared to other fermenters so that it is more easily degraded by microbes during the fermentation process. Microbes during the fermentation process are able to degrade the crude protein of feed fermentable, so that it can be used for microbial protein needs. In accordance with the opinion Yulianto et al., (2022) stated that the degradation of feed protein is determined by the ability of microbes.

**Crude Fat (%)**

Crude fat is the main constituent of animals and is an important source of stored energy. Crude fat serves as a high-density energy source. The crude fat content of this study ranged from 0.8% (coffee peel mixed, control), to 6.9% (mixed coffee peel + local microorganism tempeh yeast). The results of the analysis of variance showed that the treatment had a significant effect (P<0.05) on the crude fat content of each treatment fermented coffee peel as feed animal presented in **Figure 3**.

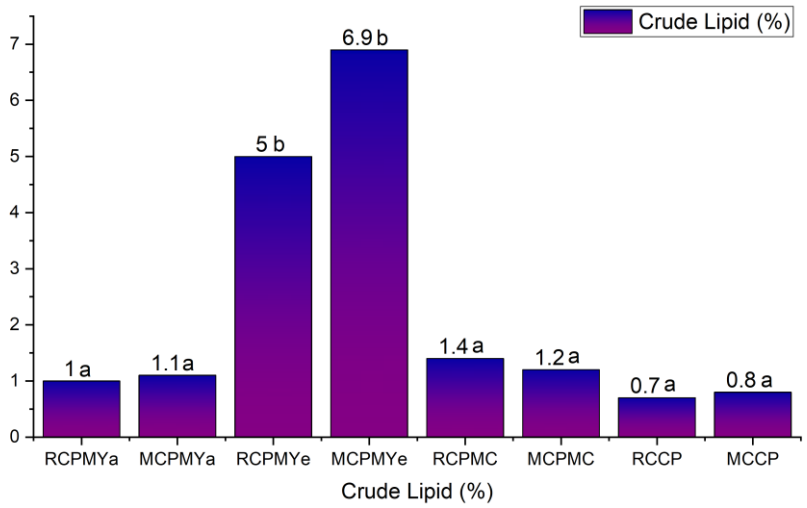


**Figure 3. Crude lipid content of fermented coffee peel waste**

The high crude fat content of mixed coffee peel + local microorganism tempeh-yeast were 6.9% because the fermentation process using local microorganism tempehyeast on the coffee peel waste is more optimal in increasing crude fat when compared to other fermenters. According to Van Soest et., (1991) states that during the fermentation process the fermenter could work optimally when the substrate and microbes used adapt to the media, so that it can improve nutritional quality and can be used during the fermentation process.

Crude fat changes with differences in physical form, feed composition, level and frequency of feeding and processing is obtained from the hydrolysis of fat by lipolytic bacteria into fatty acids and glycerol, then the glycerol is further fermented into acetate, butyrate, and valerate (Yulianto and Xuan, 2017). As reported by Satter and Slyter, (1974) that the crude fat content of a feed ingredient reflects its level of fermentability. The higher the level of fermentability of a feed ingredient, and nutrient content.

**Crude Fiber (%)**

Crude fiber is the main food for microorganisms which will be converted into Volatile Fatty Acids (VFA) as an energy source for ruminants. The results showed that the crude fiber content of fermented coffee peel waste for feed animal ranged from 11.4% (red coffee peel waste + MOL yeast) to 34.2% (control mixed coffee peel). The results of the analysis of the diversity of several fermenters different letters a, b and c were indicate significant different (P<0.01) each treatment nutritional content crude fiber of livestock rations each treatment fermented coffee husk as feed animal, which can be seen in **Figure 4**.

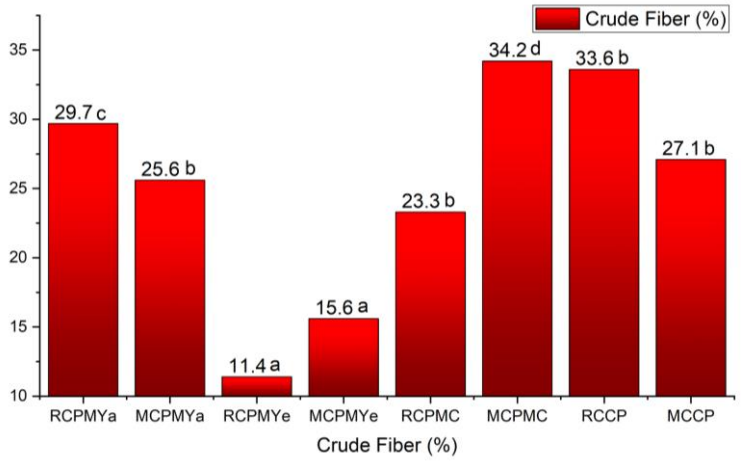


**Figure 4. Crude fiber content of fermented coffee peel waste**

The highest crude fiber content of 34.2% in the control mixed coffee peel was due to the low crude fiber from the control mixed coffee peel waste when compared to other fermenters. On the other hand, the low crude fiber 11.4% (in red coffee peel + local microorganism tempeh yeast) was due to the high 89.6% dry matter (in red coffee peel + local microorganism tempeh yeast).

According to Yulianto et al., (2018) the high dry matter content in the red coffee peel fermenter + local microorganism tempeh yeast because it has a fairly low crude fiber compared to other fermenters. The low crude fiber resulted in an increase in the digestibility coefficient and dry matter, so that the fermenter was able to degrade plant cell wall components hemicellulose and lignin (Yulianto et al., 2021). Thus, the addition of red coffee peel fermenter + local microorganism tempeh yeast was able to increase the dry matter content were 89.60%, and reduce crude fiber by 11.40%. (Cruch, 1989) stated that microorganisms in the fermentation process of ruminant feed ingredients can produce quite a lot of cellulase enzymes, so that they are able to remodel and degrade crude fiber to a lower level compared to other fermenters.

**Nitrogen Free Extract Material (%)**

The results showed that the Nitrogen Free Extract Material content of fermentedcoffee peel waste for feed animal ranged from 36.7% (mixed coffee peel + MOL yeast) to 60.2% (mixed coffee peel + MOL Yakult). The results of the analysis diversity several fermenters different little letters a, b and c were indicate significant different ($P<0.01$) of the content Nitrogen Free Extract livestock rationson of each treatment fermented coffee husk as feed animal, which can be seen in **Figure 5**.

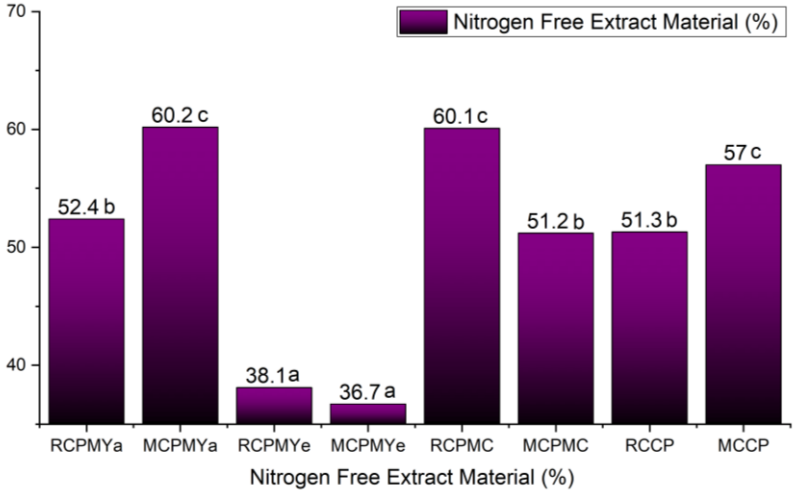


**Figure 5. Nitrogen Free Extract Material content of fermented coffee peel waste**

The highest Nitrogen Free Extract Material content of 60.2% in mixed coffee peel + local microorganism of Yakult is due to dry matter (89.3%), and crude fiber (25.6%) from local microorganism Yakult mixed coffee peel waste is higher than other fermenters, so the effectiveness of mixed coffee peel + yeast has an impact on the content of Nitrogen Free Extract Material, and other nutritional content of coffee peel waste to be used as feed. According to Nagaraja and Towe (1990) the content of extracts without nitrogen of animal feed ingredients is very dependent on other components such as crude protein, crude fiber, crude fat, ash. The amount of crude fiber, crude protein, crude fat and ash is reduced from 100, the difference is called the nitrogen-free extract (Soejono, 1990).

**Total Digestible Nutrient (TDN) (%)**

TDN is an energy partition used to calculate feed energy which is used as a reference for the preparation of feed ingredients for ruminants. The results from this study showed that the TDN content of fermented coffee peel waste for feed animal ranged from 56.7% (mixed coffee peel + local microorganism of coffee) to 72.5% (mixed coffee peel + local microorganism tempeh yeast). The results of the analysis diversity several fermenters different letters a, b and c were indicate significant different on the TDN content of fermented coffee peel using several fermenters presented in **Figure 6**.

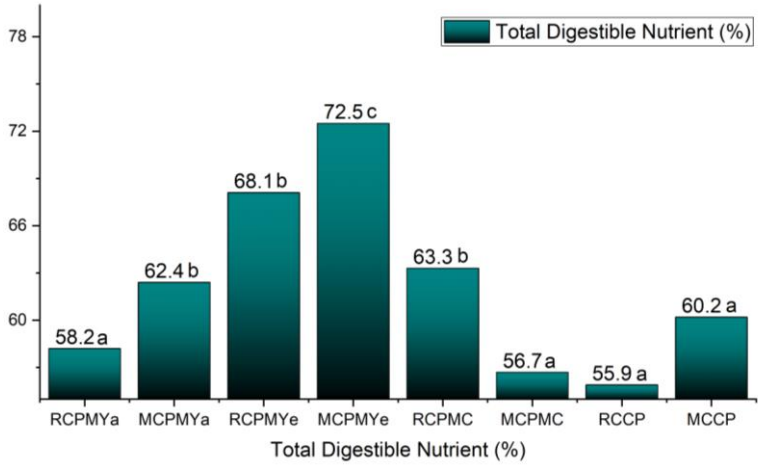


**Figure 6. Total Digestible Nutrient content (TDN) of fermented coffee peel waste**

The highest TDN content is 72.5% (mixed coffee peel + local microorganism tempeh yeast) this is because it contains 88.1% dry matter which is quite high and low crude fiber 15.6% so that it is easily degraded by microorganisms during the fermentation process. Compared to other fermenters, mixed coffee peel + local microorganism tempehyeast has the potential to become feed animal in terms of biotechnology. Fermentation process could be soluble by microorganisms to increasing the nutritional value as feed animal, so that it can improve nutritional quality and digestibility in ruminants (Yulianto and Xuan, 2017).

## CONCLUSION

The results of study related topic of the coffee peel waste biotechnology as an alternative to feed animal to support agro-industry using several fermenters, it can be concluded that the mixed coffee peel fermenter + local microorganism tempeh yeast has a high content when viewed from dry matter 88.1%, crude protein 27.2 %, Crude Fat 18%, TDN 68.1%, and Crude Fiber 11.4% lower whencomparednutritional content of the other fermenter coffee peel waste. So that the red coffee peel fermenter + local microorganism tempeh yeast is very potential for further research and application in ruminant rations.

**Author's declaration**

**Authors' contributions and responsibilities**

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of

results. The authors read and approved the final manuscript.

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**Availability of data and materials**

All data are available from the authors.

**Competing interests**

The authors declare no competing interest.

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