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# Group Cohesion Category 13-15 Basketball Team of Virgen Felizola García Sports Complex

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## A B S T R A C T

*The present study addresses group cohesion in the basketball sports team, intending to optimize their performance and the need to achieve group efficiency in collective sports. In this team belonging to the sports team Virgen Felizola García, from Santiago de Cuba, difficulties in interpersonal and intergroup relations were created, creating an atmosphere of lack of unity, individualism, which weakens the sports performance of its members. This fact motivated the question of how to improve the sports performance of the basketball team, from the elaboration of a proposal for a plan of sociopsychological intervention actions that favor the group cohesion of the studied team.*

***Keywords---****basketball, cohesion group, collective sports, sociopsychological intervention, sports performance.*

## Introduction

Basketball, also known under the name of basketball or basketball, is a sport that is played as a team, mostly on an indoor court, although there are also modalities that are practiced on the open track. It was created at the end of 1891 by the physical education teacher James Naismith, with the need to be able to perform an athletic activity in winter. This sport has achieved great development and popularity throughout the planet, being currently one of the most influential and relevant sports practices worldwide. Leagues such as the United States or those that take place in several European countries concentrate significant economic investments and many of the parties become mass events.

Its introduction in Cuba dates back to 1906 when young Cubans attending American schools began to spread and practice this game. The most outstanding result of Cuban basketball at the level of the Olympic Games has been the third place in Munich 1972 in the men's sector and the fourth place in the 1992 Barcelona Olympiad in the women's branch. Currently, in Santiago de Cuba, it has been observed the need to deal with problems related to sport, specifically in the initiation stage, one of the affected areas is the management in its pillars, such as planning, organizing, control, and evaluate emotional skills, since without it does not respond to the demands of today's society (Álvarez de Zayas, 1995; Álvarez, 1996; Buceta, 1995). In these moments it is of great importance to deepening the study of the psychosocial characteristics that objectively guide the process of group dynamics, as one of the main demands of team sports, where the actions are carried out in full interrelation and interdependence between the players who make up the team.

The need to strengthen individual and group psychological resources (team cohesion) is of paramount importance, especially in sports where the result depends on effective interaction between its members. Collective sports constitute a modality that belongs to the family of collaborators - opposition, in which the individual is the team, each player being a qualitative and integrated part of it. Each behavior depends on others and individual contributions are very important, but the athlete is not subject to an official evaluation. What counts is the final result of the team. Sports teams are groups with specific characteristics, formed by a group of people who work

collectively to perform a task, where responsibilities are shared and attempts are made to seek greater individual and collective efficiency.

The development of the research process starts from the exam to the object of study that it refers to, the group cohesion in the basketball team of the category 13 - 15 years of the Virgin Felizola García Sports Complex of Santiago de Cuba and the manifestations that appear in it. In the analysis of the aspects related to the operation of the group is the size of the team that influences its cohesion; The larger the size, the more cohesion between the members and vice versa becomes more difficult, so it is important to have good communication between the team members to achieve cohesion, as well as the role of the coach to achieve team cohesion (Cañizares, 1994; García, 1988; García, 2004).

In this sense, there are difficulties given the demands implied by the practice of basketball of the category 13 - 15 years of the Sports Team, in terms of the way of communicating, the individual and collective distrust in the achievement of the group's objectives; the lack of commitment to fulfill the individual tasks within the games or collective activities; the lack of cooperation between them tending to the accomplishment of the tasks, lack of support, help in the different individual and personal problems outside the training and competitions. From the exploration that was carried out, the following problem situation was reached: Insufficiencies in-group cohesion in the 13-15-year-old basketball team of the Virgen Felizola García Sports Complex that affects the efficiency of the sports team as a group. The following scientific problem arises: How to improve group cohesion in the basketball team of category 13 - 15 years of the Virgen Felizola García Sports Team? In this sense, the objective of the research was formulated: To develop a plan of socio-psychological intervention to improve the group cohesion of the basketball team of the 13 - 15 years category of the Virgen Felizola García Sports Complex.

## Materials and Methods

To comply with the objectives set, and intentionally selected sample of 10 athletes from the 13-15-year-old basketball team of the Virgin Felizola García Sports Team, derived from a population of 16 athletes was worked on of this team (Leicht, 2008; Cantwell, 2004). The population in an investigation is understood as the totality of elements that meet the characteristics required to carry out the said investigation (Dosil, 2004; Loforte, 2007; Sánchez, 2005). According to the population, it is the group of individuals or objects of which one wishes to know something in an investigation. For its part, the type of sampling is intentional. It is in which the researcher selects the elements that in his opinion were representative, which requires the researcher prior knowledge of the population being investigated to determine which are the categories that can be considered representative (Tamayo, 1998).

## Methods theoretical level

Analytical - Synthetic: for the study that is carried out throughout the investigation through the updated bibliography, as well as for the analysis, the interpretation of the results, since it is present in each part and moment of the steps that are rush into this process. Inductive - deductive: to make the necessary inferences in the application of empirical, theoretical, statistical methods, and arrive at conclusions. Systemic - structural-functional: it was used in the elaboration of the sociopsychological intervention plan to improve group cohesion in basketball athletes of category 13 - 15 allowing to establish and

determine its components.

**Techniques**

Interview: it is applied to the athletes of the basketball team of the category 13 - 15 years to know the characteristics of the team in terms of group cohesion since it allows them to have direct information on the aspects related to the present investigation (Erfer & Ziv, 2006; Taube-Schiff et al., 2007). The interview of the athletes of the basketball team of the category 13 - 15 years was carried out to know their opinions about the participation in the process of setting the training and competition objectives. Group cohesion test (Multidimensional Instrument for Cohesion in Sport, IMCODE): it is used to evaluate the different indicators that characterize cohesion in this category of basketball (Singh & Parmar, 2015).

**Results and Discussions**

**Techniques for analyzing the data obtained**

Once the different data have been obtained through the instruments, the data is analyzed using the quantitative analysis. That operation that is carried out naturally with all the numerical information resulting from the investigation, which once processed, will be presented as a set of tables, tables, and measurements, to which their percentages have been calculated and presented conveniently.

In this sense, the analysis of results for Hernández et al. (2010), consists of a set of strategies and techniques that allow the evaluator to obtain the desired result from the appropriate treatment of the data collected. For this investigation, the data is analyzed by applying the categorization of the data, according to the criteria of qualification and tabulation of the data, with the mediation and the use of percentage indexes, which are organized in comparative tables and graphs using descriptive statistics.

The integral analysis of the data is carried out in a comparative way that is established about the contents that cover them and that favor the discussion of the results. These are supported by a generalized interpretation based on the theoretical aspects related through the variables and according to their interrelation, the results obtained provide a solution to the questions when applying the procedures of analysis, interpretation, integration, and explanation.

Diagnosis of the behavior of group cohesion in the basketball team of the category 13 - 15 years of the Virgen Felizola García Sports Complex
Objective: Identify through the diagnosis the inadequacies in-group cohesion in the basketball team of the category
13 - 15 years of the Virgen Felizola García Sports Team.
At first, is planned the diagnosis and carried out through the following instruments:
a) Interview
b) Group cohesion test

**Among the aspects that are diagnosed:**

a) Development of cooperation, the characteristics of participation, satisfaction, adaptation, and acceptance are taken into account.

b) Group integration, through it the harmony in the relationship, social acceptance, breadth of interaction (long term, medium or short term) is valued.
c) Socio-psychological climate, inquiring about the satisfaction of group members for interpersonal relationships, joint manifestation of moods, feelings, aspirations, common orientation guidelines for the group.
d) Sense of belonging considering the identity and meaning with the team, stimulation of the members of the group.

**Socio-psychological intervention plan**

General objective: To improve the group cohesion of the basketball team of initiation the Virgen Felizola García Sports Complex, taking into account the characteristics of its members, the different processes that occur in the team and that affect their growth as a group, as well as the deficiencies found in the diagnosis (Ohnmacht et al., 2018).

**Specific objectives:**

a) To distinguish in the team situations, postures, and experiences that affect their development as a group. Search for solutions to the problems and situations that may occur and affect the functioning of the sports team among its members.
b) Strengthen group integration among team members.
c) Set common goals according to the possibilities of each team member.
d) Stimulate and create positive emotional states among team members and between them and the coach.
e) Develop an appropriate distribution of roles.

Evaluation and interpretation of the interview of the athletes of the basketball team of category 13 - 15 In the analysis of the questions, it can be seen that 8 athletes, representing 80%, consider that there is no cohesion or unity in the team that the relations between the members and between them and the coach are not the most appropriate, there is no respect and they constantly discuss. On the other hand, two athletes, who represent 20%, are not worried about the situation of the team or the results that are obtained, so there is a lack of motivation and interest, they also agree that they are the two isolated from the group.

About the fulfillment of the guidelines given by the coach, 4 athletes, representing 40%, consider that they do not always do what is oriented, that they do not exercise the technical elements with the quality and execution that they deserve, nor do they practice it in their free time; only 3 athletes, who represent 30% value compliance with the guidelines as appropriate and the remaining 3 consider that they sometimes comply, which represents 30%. The 10 athletes (100%) consider that they do not try hard enough in training and this is evidenced in the competitive results, they value this line as negative and consider that there should be a greater demand on the part of the coach and among themselves.

A total of 6 athletes (representing 60%) consider that they are discouraged from performing the same exercises and the lack of games during training, two athletes (representing 20%) did not say anything in this question, which indicates disinterest Due to the activity it performs, the remaining two athletes (20%) value the interpersonal relationships they show as a team during training and competitions as deficient, this last element has been repetitive in the rest of the instruments applied. On the concerns they have, only 3 (representing 30%) argue that they have raised them, but they are not resolved, 5

(representing 50%) consider that it is not necessary to say their concerns, and the remaining 2 (which represents the 20%) only mentioned the need to solve the serious problems presented by the team in terms of unity and competitive results. Only 4 athletes report feeling comfortable in the team, which represents 40% of the total.

Finally, the 10 athletes (100%) consider that there is no cohesion or unity in the team and this makes it difficult for the relations between them and their coach, as well as the execution of the guidelines, a total of 7 athletes (they represent 70%) they consider that there is no collaboration and help to correct the difficulties that they present in the technical - tactical order and that activities must be done to improve the unity of the group.

**Group integration test**

Sports activity, includes a wide and varied system of human relationships which exerts an essential influence on sports performance, which explains whether the general psychological principle of modification of the psychic and physical processes of the low man is taken into account the influence of different social situations. To this, in the process of direct interaction, during the training and competitions between the members of a sports team, a certain system of contacts and relationships that are determined by the nature and requirements of the activity is formed, presupposes a strict distribution of obligations according to the positions and functions of each basketball player. However, contacts and relationships between them are not limited, but in the process of joint actions both in the context of sports activity and during the fulfillment of other activities and in their leisure hours, contacts and relationships are molded. The interpersonal character that form the unofficial structure of the group and which are composed according to personal preferences and orientations.

The group integration includes the degree of adjustment that the individual has with their group and that is expressed by the qualification that the group valuation models give to social acceptance, breadth of interaction, cooperativity, and harmony of the subject's relationship. In it the following scales are appreciated:

Social acceptance is the degree to which the subject is accepted or rejected by the group to which he belongs. The amplitude of the interaction: it is the extension, of the frame of the interaction of the subject in the group or the degree of the amplitude of its relations.

Cooperativity: It represents the quality of collaborative relationships that the subject establishes in the group. Harmony of the relationship: It is the degree of friction or clash of the individual's relationships with the group. These rating scales measure the aspects described on a scale of one to five points. Where each of the members of the group evaluates the rest of the team members, which allows, for all components, a group measure of the aspects indicated, the degree of integration being the sum of these qualifications. The objective of the instrument. It is not an exhaustive measure of each of the aspects involved in the integration of the group, but a global measure of them. It is not intended to specify the intensity of the aspect in the individual, as this would be very difficult to obtain. What matters is a general assessment of the group valuation models, which allows establishing the relative position of each of the components in terms of integration. Hence the scales are ordinal type.

**Form of application of the instrument**

It is carried out in the form of a survey - interview in an individual way, where each athlete of the basketball team of the category 13 - 15, from each scale, emits the assessment of his teammates by assigning a number to each one, according to the proposition selected on the corresponding scale. Each scale consists of five options with different personal characteristics. The subject chooses in each scale the option that in his opinion meets the personal characteristics or qualities of each of the remaining team members.

**Diagnosis of group cohesion in the basketball team**

With the application of the "Multidimensional Instrument for Cohesion in Sports" (IMCODE) test, the following indicators were assessed: (1) Quality of work (aspects related to execution); (2) Attraction to the group; (3) Valued roles; (4) Quality of work (interpersonal relationships). The scale that was used was always, sometimes, or never. Regarding the quality of work, 78% consider that there are always difficulties with the discipline for the fulfillment of the strategies oriented by the coaches, 10% consider that this only happens sometimes and 12% positively value this aspect related to the discipline and compliance with the guidance of coaches. In the valued roles, it showed that 33% always value their role within the team as inappropriate, as well as the contribution they make depending on the team, 46% considered that sometimes the contribution of each team member and their contribution is well valued and 21% consider that they always do feel valued by the rest of their teammates and useful for their team.

To the roles within the team, it is confirmed that there is always a lack of support and mutual respect in 63% of the members, 34% believe that they sometimes show support and 3% always support each other, 26% consider that the roles are defined between them and act in correspondence, 56% consider that the roles are not defined within the team and 18% who sometimes know the role they should play within the team. 64% believe that coaches always prepare them mentally and physically for the competitions, 36% consider that training is sometimes lacking on the part of coaches in this regard.

As for the attraction to the group, they show that 72%, 63%, and 61% of basketball players do not show pride in belonging to the team, they do not enjoy what they do and they value very little belonging to the team, 16%, 20%, and 30% respectively consider it sometimes and the rest, 12%, 17%, and 9% never. 44% are satisfied with the friendships they have on the team, 28% are not satisfied with the friendships within the team and 28% sometimes enjoy or are satisfied with their friendships. 87% of athletes believe that there is always a lack of unity in the team and 13% consider that they are sometimes united. The results show that 79% always consider players unable to reconsider the objectives for the achievement of their goals or objectives, 8% considered that sometimes and 13% value it positively, that is, they always manage to do it. 92% of athletes believe that teamwork is always poor and 8% value it well sometimes, 65% of athletes believe that if they are accepted in the team and 73% want to continue practicing this sport, only 35% value their acceptance in the team sometimes and 27% show no interest in continuing in the team. 69% consider that they are valued by their coach, 20% consider that sometimes and 11% that they are never valued.

About the solution of conflicts and friendly relations between team members. The results show that 67% of the team members believe that there is little friendship between them that does not allow resolving conflicts that occur during training and in competitions, 15% believe that only some conflicts between

them are resolved and 18% positively value conflict resolution based on the sympathy they show among them. However, 45% of the team believes that there is a high degree of selfishness and lack of individualism, which affects the team in achieving its objectives, 28% believe that sometimes the lack of sacrifice and selfishness prevails among the members of the team, 27% do not recognize the existence of selfishness between them and that they are willing to sacrifice their glory depending on the team. While 38% of athletes consider that they are always committed to the rules set by their coaches, 44% consider it sometimes and only 18% consider it negative, that is, they never feel committed to the guidelines or rules of the trainers 88% of athletes believe that their partners do not perform their roles or functions within the team well and the remaining 12% if they positively value the functions performed by their partners within the team. To the sense of belonging, only 38% value it positively, 23% sometimes consider this aspect good and 39% consider that there has never been membership in the team. You lie that 85% of the athletes consider that they never have clarity of the objectives or what they want to achieve as a team and 15% consider that sometimes. In addition to the analysis of the data obtained with the IMCODE, special attention was given to aspects related to the context of the application of the questionnaire. In this sense, we can say that it is an easy test to administer and that it can be completed in a few minutes. Although the study involved subjects with an age range between 13 and 15 years. A small number of athletes said they did not understand the word role. However, at the time the athlete asked about this term, the rest of the teammates or the coach explained.

## Conclusion

The theoretical foundations refer to the importance of group cohesion to achieve a favorable climate in the team, which is directly related to the effectiveness and sports performance of the team. The diagnosis made showed that the category 13 basketball team - 15 years of the Virgen Felizola García Sports Complex in Santiago de Cuba, presents difficulties in terms of group cohesion, which negatively affects the socio-psychological development of this sports team. A sociopsychological intervention plan was developed to improve group cohesion, taking into account the theoretical and methodological foundations that support the work of the sports team as a group

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# Design and Construction of a Cold Room with Photovoltaic Support for Lighting

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## A B S T R A C T

*One of the problems encountered today is the inefficiency of refrigeration systems and electrical equipment. The present study proposes the manufacture of a refrigeration chamber that responds to a great variety of needs both in industrial processes, medicine, and domestic service, becoming an indispensable process within the socio-productive sector. The proposed system has an investigative scope, as a contribution to the agricultural food sector for the derivation of variables and the behavior of products (plants-food) and its method of conservation for quality towards the consumer. The type of investigation responds to the experimentation supported by an observation card with variable rate testing tests. Given the aforementioned, a freezing and refrigeration system is elaborated, taking advantage and optimizing an air conditioning system that works up to 24°C in the room and under the modification obtain temperatures of -15°C, starting from an average temperature of 29°C and a 65% relative humidity of the outside. For the selection of the equipment, the installed capacity of 1.5 tons of cold was considered with an average consumption of 6 amperes/hour, R22 refrigerant gas (SA, 2009) and for its verification, an electronic controller TH20 (RCA) was used; As a product, water is used, reaching freezing after 20 minutes of operation of the equipment.*

***Keywords---****freezing, installed capacity, photovoltaic panel, R-22 gas, temperature, TH20 roller.*

## Introduction

Refrigeration is a process that consists of reducing or maintaining the temperature according to the products being treated, spaces, or even materials concerning the temperature of the environment around them. At present, refrigeration has a wide variety of applications and is involved in a series of industrial processes ranging from the food sector, chemistry, medicine, and even in the treatment of metals. This research is part of a research process that began with the design and construction of a conditioning system for industrial buildings (Muñozet al., 2020).

Refrigeration by mechanical compression (Quinto et al., 2005), is responsible for removing the energy from the hot sink where the products are stored, that is, its objective is to control the temperature according to the needs of preserve food in stable conditions for marketing.

At the territorial level Ecuador, along with its coastal profile, its agricultural production is based on fishing with 60%, which leads to the manufacture of cold rooms for conservation and commercialization both for large producers and retailers, being the Manta canton, from the province of Manabí, the tuna exporter in the first order at the regional level, the majority commercialized in the United States, Europe, and Asia (FAO, 2017). Given the aforementioned, Ecuador is an important global player in the tuna industry. In the eastern Pacific Ocean, it has the largest purse seine fleet, main catch, and the largest processing capacity. The highest number of one is exported processed (cans and bags) or as precooked tuna loins for the second transformation (Rehman et al., 2017; Gooding et al., 2013). The main tuna

stocks are close to maximum yield, there are significant concerns regarding the overcapacity of the fishing fleet and the impact of some fishing techniques on the stocks of tuna and other marine species (eg sharks).

Dorado fishing represents around 65% of large pelagic fish landings and is the main export product of white fish (40%) (Ministry of Aquaculture and Fisheries, 2014). Given the aforementioned, it is essential to meet local needs, national and regional at a global level in the field of food preservation in order of production such as meat products, flowers, chemicals, and health; guaranteeing quality and reliability at the service of society. In the study base, guidelines are established such as the materials of the chamber, including expanded polyethylene, resin polymer plates, iron, and adjustment elements for their fixation (Gónzalez de la Cruz & Gónzalez, 2006). Information was sought related to the use of photovoltaic solar panels in cooling (Bravo et al., 2018; Nižetić et al., 2016), and information was sought on 15 W panels (Solar, 2021), controller, battery, pilot lights.

The photovoltaic system will make it possible to take advantage of the solar energy that can be obtained in the area, mainly in the coastal of the province of Manabí (Rodríguez & Vázquez, 2018; El Mays et al., 2017), where radiation levels are very high and can be active for different uses. The implementation of the use of renewable energy sources helps to achieve sustainable energy development (Pérez et al., 2020). The objective of the research is to design a refrigeration system that can be operated under special conditions and that the lighting inside the chamber is carried out with the operation of a photovoltaic system.

## Materials and Methods

This research was developed in the city of Portoviejo - Manabí - Ecuador position 341° N, 170ft height, 1 atm. Atmospheric pressure; at the facilities of the Paulo Emilio Macías Higher Technological Institute, with an experimental design based on several testing tests at variable rate interval, applied to a refrigeration system, proposed as an eco-sustainable technology transfer alternative that is intended to be achieved from ambient temperatures of 30°C to -2°C.

## Results and Discussions

The alternative of improving efficiency and starting with the path of sustainability and use of indigenous resources (Gámez et al., 2019), decreasing environmental impacts. The design of a cooling system has started. For its construction, different materials and equipment have been used that will allow it to materialize as an industrial and commercial conditioning system already in operation. Some materials and equipment that were used for construction are listed, for example, the mechanical cold equipment, photovoltaic system, pipes of different dimensions, contactor, pilot lights, controller, refrigerant gas, expanded polystyrene, sealing rubber with a magnet, angles of different dimensions, electrodes, tubes, among other materials.

## Description of the refrigeration system

This prototype is part of the process of reuse or recycling of elements, materials, or components that are out of operation, helping to reduce environmental pollution due to the manufacturing factor of new products, it uses electronic control to optimize the operation and improve efficiency (Real Pérez, 2017),

for the internal lighting of the cold chamber a photovoltaic system was incorporated, to supply the electric current thereby reducing consumption energy and therefore reduce environmental impacts achieving sustainability over time. In figure 1 the cold room is shown and in figure 2 the control system of the room.

Figure 1. Cold room

Figure 2. Room control system

The cold room has an installed cold capacity of 12000 Btu / hr, with its equivalents of 3330 Kcal/hr, under the work of a mechanical compression system at the dry regime. The humidity and temperature sensor system, as well as the machine on and off, will be in charge of the TH – 20 controller to achieve the best performance of the equipment where refrigeration and freezing temperatures can be obtained. automating processes according to the demand of the products in conservation. The mentioned controller works with two capacitive type sensors, which react to metals and non-metals, framed by the connection distance depending on the material, being greater when the dielectric constant is higher (TURCK, 2020), its installation will be in the evaporator unit, and the humidity sensor in the center of the cold room (Logicbus, 2020).

The cold chamber has a volume of 9.36 m3 with a capacity of preservation products of approximately 250 Kg, the walls are made of insulating materials for heat transfer such as expanded polyethylene K = 0.035W / m ° K, polymer sheets of resin with a coefficient K = 0.12 W / m ° K. (Syrek et al., 2020; Oh & Son, 2011; Cho & Tae, 2001) on both surfaces with a thickness of 0.05 meters. The internal lighting system of the chamber is made using a photovoltaic system that satisfies an energy demand of 10 W / hours, under the light-emitting diode system, being a sustainable lighting system. Table 1 shows the technical characteristics of the photovoltaic solar panel.

Table 1
Technical characteristics of the Photovoltaic Solar Panel

| Description | Quantity |
|---|---|
| Output voltage | *18 V dc.* |
| Maximum output current | *0.83 A.* |
| Power | *15 Watts* |
| Open circuit voltage | *22 V.* |
| Short circuit current | *0.9 A.* |
| Dimensions of the Solar Panel | *39 X 36 X 2 (cm)* |

**Verification process**

The data verification process expected by the cold production equipment is carried out in the Laboratory Workshop of conditioning systems and refrigeration from the Paulo Emilio Macías Higher Technological Institute, with data from variable measurements. The measuring instrument used a TH-20 temperature and humidity controller, with the following characteristics shown in table 2 the technical data of the TH 20 series controller.

Table 2
Technical characteristics of the temperature and humidity controller

| Description | Quantity |
|---|---|
| Contact Capacity | 10 amp / 250V |
| Control | -40 ° C ~ 80.0 °C |
| TemperatureTemperature | 0.0 ~ 99.9% RH% RH |
| Operating | 10 to 100(No Condensation |
| HumidityHumidity | +/- 0.5 ° C, +/- 3% RH |
| Measurement Accuracy | |

Source: Research Group

**Technical Operating Parameters System**

**Table 3 shows the data and freezing chamber sampling freezing chamber**

Table 3
Sample

| Test | No. Internal vacuum chamber temperature (° C) | Equipment operating time (minutes between on and off) | Operating time min. |
|---|---|---|---|
| 1 | 24 | 0 | 0 |
| 2 | 18 | 1.2 | 1.2 |
| 3 | 15 | 1.35 | 2.55 |
| 4 | 12 | 1.2 | 3.75 |
| 5 | 10 | 1 | 4.75 |
| 6 | 8 | 0.95 | 5.7 |
| 7 | 6 | 0.88 | 6.58 |
| 8 | 4 | 0.7 | 7.28 |
| 9 | 1 | 0.7 | 7.98 |
| 10 | -2 | 0.71 | 8.69 |
| 11 | -4 | 0.73 | 9.42 |
| 12 | -6 | 0.74 | 10.16 |
| 13 | -8 | 0.76 | 10 .92 |
| 14 | -10 | 0.72 | 11.64 |
| 15 | -13 | 0.95 | 12.59 |
| 16 | -15 | 0.9 | 13.49 |
| 17 | -18 | 0.99 | 14.48 |
| 18 | -20 | 1 | 15.48 |

**Analysis of team results of freezing**

In figure 3, the correlation of temperature concerning the number of samples taken is shown.

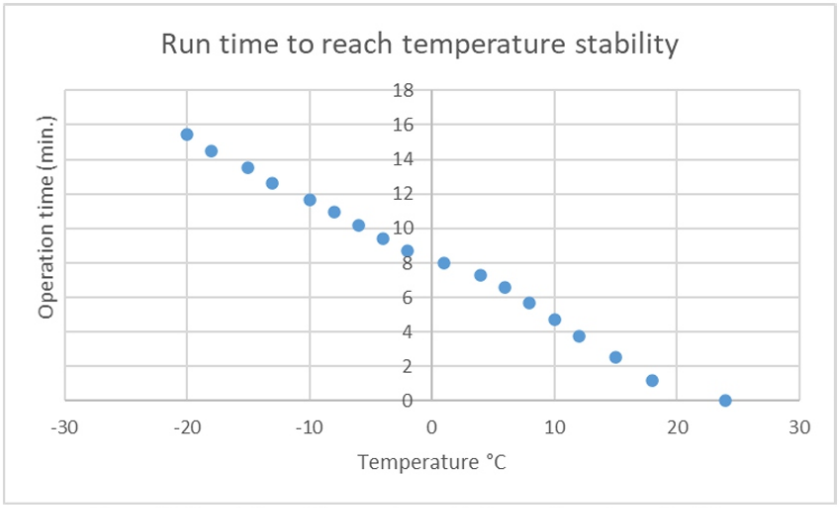


Figure 3. Correlation of temperature with the number of samples taken
Source: Research group

Strong negative correlation with -0.9978 data in works at the 18 randomized tests selected in sampling, which means that over time approximately 15.48 minutes for the equipment to reach lower temperatures starting from 25 ° C (room temperature) to -20 ° C inside. Figure 4 shows the correlation between operating time and temperature reached.

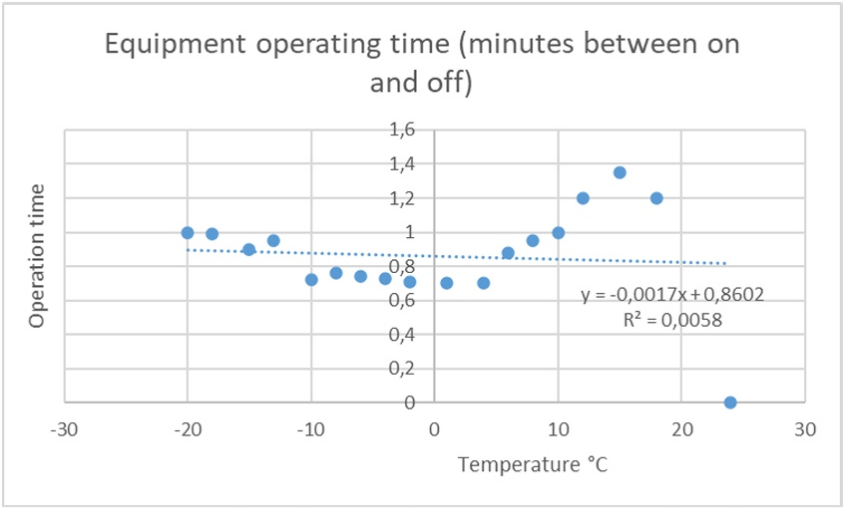


Figura 4. Correlación de tiempo de operación y temperatura alcanzada

With the very low negative correlation with - 0.07612, it can be seen that there are no specific times between stop and start of the equipment to obtain indicated temperatures, its assessment is based on variables such as capacity volume and external environmental conditions. Figure 5 shows the graph of the equipment humidity correlation as a function of the internal chamber temperature.

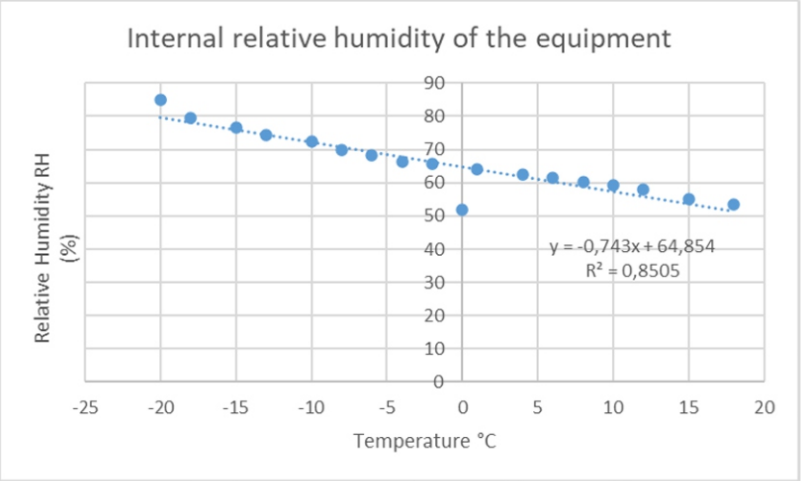


Figure 5. Equipment humidity correlation as a function of the internal chamber temperature

The strongly negative correlation -0.9836, can be seen in the graph that the relative humidity is closely proportional to the temperatures generated, the higher the temperature, the lower the humidity and if there is a lower temperature inside the system, the higher the relative humidity; taking as a condition that the equipment always works without a dehumidifier, that is, in a standard atmosphere at sea level. As a result of the experimentation, in liquid products there is a presence of freezing in approximately 20 min, from the first phase of on and off the compressor, reaching the average internal chamber temperature of -8.53°C, with its standard deviation of 4.67°C., likewise registers an average liquid product temperature of - 0.5°C and its standard deviation of 1.03°C.

Contrasting the results with those of (Eduard et al., 2010) who analyzed several samples of breast milk at a temperature of -20ºC in terms of their protein quality and storage time, it was possible to reach 90 days preserving its properties. In products such as vegetables, the conservation begins in approximately 20 min, from the first phase of switching the compressor on and off, reaching the internal temperature of the chamber of -7.8°C with its standard deviation of 3.18 ° C. It also records a temperature. vegetable product average of 3.5°C and its standard deviation of 1.95°C. In a study by (García & Pacheco, 2007) two morphotypes of celery, yellow and white, were stored at a temperature of 10ºC, obtaining results of non-susceptibility to cold, maintaining the physical characteristics for 5 days with average weight losses of 13.73 g water / 100g in white celery and 17.65 g water / 100g in yellow.

In meat/fish products, preservation occurs in approximately 40 min, starting from the first phase of turning the compressor on and off, reaching the internal chamber temperature of -6°C with its standard deviation of 2.68°C. It also records an average meat/fish product temperature of 0.22°C and its standard deviation of 3.21 ° C. In the study by (Rota & González, 2006) samples of flying fish were stored in a domestic type chamber at –18°C for ninety-five days, an estimated shelf life according to previous tests carried out by the crew of the boat that supplied the fish. On the other hand, even though the final product was frozen twice, once on the high seas and the other under the modality of fillets in trays, no signs of deterioration were observed, since rapid freezing methods were used in both processes. Furthermore, defrosting before filleting was carried out at a low temperature (-18ºC), to avoid excessive dripping

## 4 Conclusion

A refrigeration chamber was built that serves a great variety of canned processes for industries, medicine, and domestic service, of importance within the socio-productive sector. A photovoltaic system was used for lighting inside the chamber and achieving the sustainability of the cooling system, improving energy efficiency and reducing the environmental pollution.

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# Quality of Bali Beef Cut on Different Management of Slaughterhouses (RPH) in Bali Province

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## A B S T R A C T

*The purpose of this study was to determine the physical, chemical and microbiological quality of Balinese beef from Slaughterhouses (RPH) with different management in Denpasar City and Badung Regency as abattoirs that supply most of Bali beef on the island of Bali. The material used was male Bali beef in the Longisimus Dorsi (LD) muscle which was cut at three different abattoirs. The RPH are UPT RPH Mambal, UPT RPH Pesanggaran and RPH belonging to the community of RPH Darmasaba in Banjar Bersih Darmasaba Village. This study used a completely randomized design (CRD) with 3 treatments where three abattoirs were treated and each treatment consisted of 10 repetitions of Bali beef cuts. The variables sought in this study were physical quality variables, namely pH, color, water holding capacity, and meat cooking loss. Chemical quality variables are meat moisture content, protein content, fat content and ash content. Meat microbiological variables were TPC, colliform, e-coli and salmonella. The results showed that the physical quality of Bali beef slaughtered at the Darmasaba RPH had the lowest physical quality compared to the Mambal and Pesanggaran abattoirs, especially on the pH and meat color variables. The chemical quality of Bali beef slaughtered at the three abattoirs had no significant difference in water content, protein content, and ash content. The total plate count, coliform was below the SNI threshold while e-coli was not identified and salmonella was negative.*

***Keywords---****Bali cattle, chemical, meat quality, microbiological, physical, Slaughterhouse*

## Introduction

Meat is a food that has high nutritional value because it contains quite complete nutrients, both micro and macronutrients such as protein, fat, minerals and vitamins that are needed by the body (Ernawati et al., 2018). Beef is the choice of many consumers in meeting the needs of animal protein consumption in Indonesia. Consumption of beef and buffalo in 2019 reached around 782.40 thousand tons or around 2.93 kg per capita per year, and within 2 years the consumption of beef has increased by 11 percent when compared to the study of staples in 2017 (Agency Center for Statistics, 2021). Beef consumption continues to increase until in 2021 the total number of cattle slaughtered at slaughterhouses (RPH) in Indonesia is recorded at 913,885 heads (Central Bureau of Statistics, 2022).

The need for beef continues to increase due to increasing demand and public awareness of the importance of nutritious food (Soeharsono et al., 1990; Suardana et al., 2017).

With the increasing public demand for meat, the quality of meat is very important to be considered by consumers in choosing meat. Meat quality is a consumer reference in choosing meat. According to Soeparno (2011), indicators that can describe the physical quality of meat are pH, water binding capacity by meat protein and cooking loss. The chemical quality or nutritional value of meat is related to the content of protein, fat, carbohydrates, minerals and vitamins contained in the meat. The microbiological quality of meat is also very important to look at the safety aspects of meat, especially the contamination of pathogenic bacteria in meat which will affect the health of consumers (Pinero et al., 2008; Zinoviadou et al., 2009).

Meat quality is determined by factors before slaughter and factors after slaughter. According to Hidayat et al. (2016), meat quality is strongly influenced by factors before slaughter including genetics, species, nation, type of livestock, sex, age, feed including additives (hormones, antibiotics, and minerals) and stress factors. The condition of livestock before slaughter greatly affects the quality of the meat produced (Rahayu, 2009). The conditions before the slaughter were very closely related to the management of the abattoir where the cattle were slaughtered. The management includes whether or not there is a rest before slaughtering, inspection of livestock before slaughter and after slaughter, handling of livestock before slaughter whether or not it follows animal welfare rules and slaughtering techniques whether carried out by professional officers or not (Grunert et al., 2004; Meng & Doyle, 2002).

Bali cattle on the island of Bali are slaughtered at RPH managed by the government and the community. Slaughterhouses (RPH) in the city of Denpasar and in Badung Regency as the RPH which supply the largest beef to the city of Denpasar have variations in management. Some of the operational RPH are managed by the government, some are managed by the community, which of course has different management. This difference in management allows for differences in the quality of the meat produced. For example, government-run abattoirs generally have antemortem and post-mortem inspections for cattle to be slaughtered, while in community-run abattoirs there is no such inspection. Differences in the handling of resting livestock, as well as handling and arching techniques will cause differences in the quality of the meat produced (Zebeli et al., 2012; Hejnfelt & Angelidaki, 2009). This study was intended to map the physical, chemical and microbiological quality of meat from several abattoirs operating in the cities of Denpasar and Badung. The abattoirs managed by the government and the community in Denpasar City and Badung Regency are the abattoirs with the largest number of cattle slaughtering among regencies in the province of Bali. The annotation above is very important for meat consumers in selecting quality meat (Mach et al., 2008; Nagaraja & Titgemeyer, 2007).

## Research Methods

### Materials and Methods

Bali beef loin portion of the LD (longisimus dorsi) muscle originates from the government-owned RPH where this RPH is managed by the Badung Regency government, namely the Mambal RPH and the Denpasar City Government, namely the Pesanggaran RPH and the community-owned RPH Darmasaba which are managed by individuals located in Banjar Bersih Darmasaba, Abiansemal District, Badung Regency. The three RPH have so far been known as the largest Balinese beef supplier RPH to Denpasar City. The beef from the three abattoir management systems will be tested physically, chemically and microbiologically at the Livestock Product Technology and Microbiology Lab, Faculty of Animal Husbandry, Udayana University.

### Research Design

The design used was a completely randomized design (CRD) with 3 treatments and 10 replications. The replications used were male Bali beef which was slaughtered with relatively the same weight and age in the three abattoirs. The three treatments are as follows:
P1: Bali beef cut at the Mambal RPH
P2: Bali beef that is cut at the Pesanggaran RPH
P3: Bali beef slaughtered at RPH Darmasaba

## Physical Quality Test Method

### Flesh color

The color of the meat was observed by comparing the color of the meat sample with the standard of meat color. The comparison color standard used is "Photographic Color Standard For Muscle and Fat Color", Department of Agriculture, Western Australia with the following color scores: light brown (1), pale pink (2), pink (3), pink (4 ), bright red (5), (6) dark red.

### Degree of acidity (pH)

Measurement of meat pH using a pH meter, starting with standardization of a pH meter with a buffer solution of pH 4 and pH 7. Then, ± 10gram meat samples were crushed and then put in a glass beaker and added with aquadest with a ratio of meat samples: aquadest (1:1). The sample was stirred and then allowed to stand for 1 minute. After that, the pH meter was immersed in the sample solution.

### Water holding capacity

Measurement of water holding capacity using a Clement 2000 centrifuge. A total of ± 10 grams of meat samples were crushed, then weighed and recorded as initial weight. Furthermore, the meat was wrapped in Whatman 41 filter paper, put into a centrifuge at a high speed of 36,000 rpm for 60 minutes. Then the sample was weighed without filter paper to obtain the final weight. The percentage (DIA) is calculated by the formula:

$$\text{Water Holding (\%)} = 100 - \left(\frac{(Meat\ Residue\ Weight)}{Sample\ Weight}\ x\ 100\right)$$

### Cooking loss

Meat cooking loss measurement begins with preparing a sample of ±30 grams of meat, then the sample is put in a plastic bag. The plastic bag was folded and clipped, after that, it was boiled at 80°C for 60 minutes. The sample was then taken and wiped with a tissue without pressing it and weighed as the final weight. The percentage of cooking loss is calculated by the formula:

$$SM\ (\%) = \frac{(Weight\ before\ cooking - Weight\ after\ cooking)}{\text{weight before cooking}}\ x\ 100\ \%$$

## Meat Chemical Quality Test Method

### Water content

Moisture content was determined directly using an oven at 1050C. First, the empty cup was dried in an oven at 1050C for 15 minutes and cooled in a desiccator, then weighed. A total of 1.5 grams of the sample was put in a weighing cup and then dried in an oven at 1050C for 3-4 hours. The cup containing the dried sample was then transferred to a desiccator, cooled for 30 minutes and then weighed. Drying was carried out until a constant weight was obtained. Calculation of water content can be calculated by the formula:

$$\%\ \text{Water content} = \frac{(\text{Initial weight of sample} - \text{Final weight of sample})(g)}{\text{Initial weight of sample (g)}}\ \text{x}\ 100\%$$

**Protein Level**

A total of 0.3 grams of sample, was placed in a vapodest tube and added 1 grain of selenium catalyst and 5 ml of concentrated H2SO4, then carried out destruction (heating in a boiling state) for 1.5 hours until the solution is clear. After cooling, 50 ml of distilled water and 20 ml of 40% NaOH were added, then distilled. The results of the distillation were accommodated in an Erlenmeyer flask containing a mixture of 20 ml H3BO3 and 2 drops of pink green bromine cresol. After the distillate volume (distillate) became 100 ml and turned bluish in color, the distillation was stopped and the distillate was titrated with 0.1 N HCL until pink. The same treatment was carried out for the blanks. With this method, crude protein content is obtained which is calculated by the formula:

$$\% \text{ Crude Protein Level} = \frac{(S-B)\ x\ 0{,}1\ x\ 14\ x\ 6{,}25}{W\ x\ 1000}\ \text{x } 100\%$$

Annotation:
S: sample titrant volume
B: Volume of blank titrant
W: dry sample weight

**Fat level**

Determination of fat content by Soxhlet method. 2 grams of meat sample (A) were weighed and wrapped in filter paper and put in a lead, dried in an oven for 9 hours at a temperature of 1050C. The soxtherm tube was dried in an oven for 3 hours at 1050C, then cooled in a desiccator and weighed (B). The lead containing the sample after being dried was put into a soxtherm tube, filled the soxtherm tube with 200 ml of n-Hexane until the sample was completely immersed. Extraction for 4 hours in a soxtherm apparatus, then air dry the soxtherm tube in a forced oven for 15 minutes then dry for 3 hours in a dry oven at 1050C, cool in a desiccator for 30 minutes, weigh the soxtherm tube containing fat extract ©. The percentage of fat content is calculated as follows:

$$\text{Fat level } (\%) = \frac{\text{C} - \text{B}}{\text{A}}\ x\ 100\%$$

Annotation:
A: sample weight (grams)
B: weight of soxtherm tube (grams)
C: soxtherm tube weight + fat extract (grams)

Ash Level

The porcelain dish was heated in an oven at 100-1050C for 30 minutes, then cooled in a desiccator and weighed to a constant weight. A total of 1 gram of the meat sample was put into a porcelain dish and weighed, then burned until it no longer smoked and ashed in a kiln at 6000C for 3 hours until it was white and the weight was constant. Turn off the furnace, leave for 12 hours and then cool in a desiccator for 30 minutes. After that, the sample was weighed.

$$\text{Ash content } (\%) = \frac{\text{ash weight}}{\text{sample weight}}\ \text{x } 100\%$$

**Microbiological Quality Test**

**Total Plate Count (TPC)**

The TPC test steps are: smoothing the sample (beef), weighing the sample as much as 5 grams. According to Waluyo (2008), the dilution stage starts from making a sample solution of 10 ml (a mixture of 1 ml/gram sample and 9 ml of peptone solution). From this solution, 1 ml was taken and put into the next test tube so that the desired dilution was obtained. Next, take the solution from the last 2 test tubes (10-7 and 10-8), pour it into a petri dish then add agar in the form of media and rotate it like number 8 so that the sample and media are well mixed and solidified then the tube is incubated at 37oC for 2 x 24 hours. The number of bacterial colonies can be calculated using the following formula:

$$\text{CFU} = \frac{number\ of\ bacterial\ colonies}{dilution\ factor} \times poured\ sample$$

**Total Coliform and Escherichia coli**

The method used to obtain total Escherichia coli and Coliform bacteria is the spread method Fardiaz (1989), using EMBA media, which is 5 grams of beef put into an Erlenmeyer tube which already contains 0.1% peptone water solution with a volume of 45 ml, so that a dilution of 10-1 was obtained. The 10-1 dilution was then homogenized and diluted again by taking 1 ml through a pipette and then put into a test tube which already contained 9 ml of peptone solution to obtain dilutions of 10-2 and 10-3.

From a dilution of 10-1 taken using a sterile pipette as much as 0.1 ml was then poured on the surface of the solid EMBA media into a petri dish and then incubated at 370C in an inverted state, and the results can be calculated after 24-48 hours. Planting was carried out at dilution levels of 10-1, 10-2 and 10-3. To count bacterial colonies that grew using the plate count method, namely by selecting the number of colonies that grew in petri dishes ranging from 30300 colonies (Fardiaz, 1989).

$$\text{Formula: Colonies/gram} = \text{Number of Colonies per cup x } \frac{1}{faktorpengencer}$$

**Statistical analysis**

The data on the physical and chemical quality of the meat obtained were analyzed using a variance. If there was a significant difference ($P<0.05$) between treatments, the analysis was continued with Duncan's multiple-distance test (Steel & Torrie, 1993). Meat microbiological data were analyzed descriptively. The analysis was assisted by the SPSS 20 program.

**Results and Discussion**

Physical quality of meat

The value of the physical quality of the meat (Table 1) which is reflected in the variables of pH, color, water binding capacity of the meat and the cooking loss value of the meat produced by the three abattoirs are as follows:

Table 1
The physical quality of Bali beef slaughtered at different abattoirs

| Variable | RPH Mambal | RPH Pesanggaran | RPH | Variable | RPH Mambal |
|---|---|---|---|---|---|
| pH | 5,77[a 2)] | 5,73[a] | 5,93[b] | 0,03 | 5,4-5,8 |
| Color | 5[a] | 5,25[a] | 6[a] | 0,15 | 1-5 SNI 3932:2008 |
| Water Holding Capacity (%) | 23,48[a] | 23,35[a] | 27,44[b] | 0,48 | 20-60% |
| Cooking Loss (%) | 32,84[a] | 33,17[a] | 31,99[b] | 0,16 | 15-40% |

**Annotation:**

1. SEM is "Standard Error of Treatment"
2. Values with different letters in the same row, significantly different (P<0.05)

The pH values of Bali beef slaughtered at the Mambal RPH (P1), Pesanggaran RPH (P2) and Darmasaba RPH (P3) were 5.77, 5.73, 5.93, statistically significantly different (P<05). The highest PH value was found in meat slaughtered at Darmasaba RPH, which was 5.93. This pH value is above the ultimate meat pH from 5.4 to 5.8 (Soeparno, 2011). It is suspected that the meat produced from the slaughter of the Darmasaba abattoir is produced from Bali cattle which are thought to be under stress. It is suspected that the animals experienced stress during slaughter and handling before slaughter. The handling of cows at the Darmasaba RPH before slaughter when the cow is laid down still uses the manual method, namely by using rigging. The cow is tied on all four legs then the rope is pulled together and causes the cow to fall. When a cow falls, it is slaughtered by a butcher. In contrast to the handling of cows at the Mambal and Pesanggaran RPH, in these two government-owned abattoirs, the handling or laying down of cows before being slaughtered uses mechanization, namely with a threshing machine. Cows that are ready to be slaughtered are put into a threshing machine and slowly the machine will lay down the cow perfectly without violence. The slaughtering at the Darmasaba RPH is carried out by uncertified or untrained butchers. Meanwhile, the cuts at RPH Mambal and Pesanggaran are carried out by Juleha (halal slaughter attendant) who has been certified from MUI (Indonesian Ulema Council).

Factors that affect the rate and magnitude of the decrease in pH are divided into two, namely intrinsic factors consisting of species, muscle type, muscle glycogen, and variability among livestock. While extrinsic factors include environmental temperature, cutting treatment, cutting process and stress before cutting. When cattle are stressed a lot of energy will be used to cope with stress, so glycogen reserves are almost depleted. As a result, at the time of cutting only a little glycogen is converted into lactic acid so that the pH of the meat remains high. This is in accordance with the opinion of Judge et al. (1989) namely stress before slaughter, aggressive behavior among cattle or excessive movement has a major influence on the decrease or depletion of muscle glycogen and will produce dark meat with a high pH (Thyagaraju, 2016; Jamuna, 2015).

A high pH value of meat will result in a higher or darker color of the meat. This is reflected in the color of meat slaughtered at Darmasaba RPH which has the highest/darkest value compared to the color of Bali beef slaughtered at Mambal RPH and Pesanggaran RPH which was statistically significantly different, (P<0.05). A high pH value of meat will cause the meat to be dark in color. Mounier et al. (2006) stated that stress conditions can increase blood cortisol concentrations and are accompanied by glycogen

depletion in muscles. This causes a decrease in postmortem lactic acid production and the pH of the meat remains high. The high pH value of meat results in a closed meat structure, so that the water holding capacity is high (Buckle et al., 2007).

The water-holding value of Balinese beef slaughtered at RPH Mambal, RPH Pesanggaran and RPH Darmasaba were 23.48%, 23.35% and 27.44% statistically significantly different (P<0.05). The value of the water holding capacity of the meat in this study was influenced by the pH value of the meat. This is in accordance with the opinion of Jamhari (2000), that several factors can cause variations in the water holding capacity of meat including: pH factor. The increased pH value results in high water holding capacity Sunarlim & Usmiati (2009), this is due to the high pH value of the meat resulting in a closed structure of the meat so that the high water holding capacity of the low pH value of the meat results in the open structure of the meat thereby reducing the water holding capacity. Table 1 shows that the increase in the pH value was followed by an increase in the water holding capacity of the meat. The value of the meat binding capacity of the three abattoirs was still in the normal range of 20-60% (Soeparno 2011). According to Soeparno (2011), cooking loss is influenced by water holding capacity, high water holding capacity causes low cooking loss, and vice versa. The increase in the value of water holding capacity in this study on meat slaughtered at the Darmasaba RPH was followed by a decrease in the cooking loss value. This is also in accordance with the opinion of Tambunan (2009) that the cooking loss value is closely related to the binding capacity of water. The higher the water binding power, the less water and nutrient liquid will come out or wasted during the heating process, so that the mass of the meat will decrease slightly. A low cooking loss value will make the quality of the meat better. This is confirmed by Yanti et al., (2008), that meat that has a low cooking loss value below 35% has good quality because the possibility of releasing nutrients from the meat during cooking is also low. In accordance with this statement, the data of this study showed that all meat slaughtered in the three abattoirs was within the normal range of 15-40%.

**Chemical quality of meat**

Moisture content is the percentage of water content of a material which can be expressed by wet weight or dry weight. The results of variance showed that Bali beef with different slaughterhouse treatments at different abattoirs had no significant effect (P<0.05). Although there was a difference in the water holding capacity of the meat, namely the highest water holding value of Balinese beef slaughtered at the Darmasaba RPH, it did not affect the water content of the meat. This is because the range of water-holding capacity of the meat in the three treatments is still in the normal range (20-60%). Muscle contains about 75% water with a range of 68-80%, if the water content of the meat exceeds the normal water content (75%) it can reduce the quality of the meat. Fausiah & Al Buqhor (2019), research found that the water content of Bali beef in the traditional market of Polewali Mandar district, South Sulawesi, 74.85-77.98% Meat with high water content will look pale, runny and have a soft texture because a lot of water is bound to come out of meat. The high water content in meat causes less water-soluble protein so the waterholding capacity of meat protein will decrease.

Table 2
Chemical quality of Bali beef slaughtered at different abattoirs

| Variable | RPH Mambal | RPH Pesanggaran | RPH Darmasaba | SEM |
|---|---|---|---|---|
| Water content (%) | 70,88[a] | 71,54[a] | 70,64[a] | 0,20 |
| Protein Content (%) | 25,93[a] | 26,09[a] | 26,19[a] | 0,13 |
| Fat level (%) | 1,57[a] | 0,88[b] | 1,65[a] | 0,09 |
| Ash content (%) | 1,04[a] | 0,98[a] | 1,06[a] | 0,01 |

**Annotation:**

1. SEM is "Standard Error of Treatment"
2. Values with different letters in the same row, significantly different (P<0.05)

Along with the water content which was not significantly different, the protein content of Bali beef slaughtered at the three abattoirs also showed results that were not significantly different (P<0.05). Protein is the largest chemical component in meat that has an important role for growth, cell maintenance and as a source of calories. Different water content can cause differences in protein content, because protein has a close relationship with the water content of meat, especially the hydrophilic nature of muscle protein in binding meat molecules. In general, meat contains relatively constant amounts of protein and there may be no difference between breeds. According to Soeparno (2011) the protein content of meat ranges from 16-22%. The results in this study protein levels can be said to be very good because the number is above the normal value. The fat content of meat in this study was Bali beef slaughtered at the Mambal RPH 1.57%, at the Pesanggaran RPH 0.88% and at the Darmasaba RPH 1.65% statistically significantly different (P<0.05). The lowest fat content in Balinese beef slaughtered at the Pesanggaran RPH. This is because the water content of the meat slaughtered at the Pesanggaran RPH is the highest. Body water content is inversely proportional to body fat content. According to Soeparno (2011) the fat content of meat ranges from 1.5-13%. Research by Abustam & Ali (2004) found that the fat content of Bali beef ranged from 1.56 to 4.31%. Ash content is a component of inorganic substances that are not burned in the combustion process. The results of variance showed that Bali beef slaughtered at different abattoirs had no significant effect (P>0.05) on the ash content of Bali beef. According to Sugeng (2004), foods derived from animal sources have a high ash content, this is due to some of the minerals contained in them such as calcium, iron, and phosphate. The high and low ash content is determined by the presence of minerals that are difficult to dissolve in the meat. In general, the chemical quality of Bali beef slaughtered at different abattoirs did not have a significant effect. These results are consistent with previous studies where meat quality is more influenced by extrinsic factors such as feed and rearing management (Guerrero et al. 2013).

Table 3
Microbiological quality of Bali beef slaughtered at different abattoirs

| Variable | RPH Mambal | RPH Pesanggaran | RPH Darmasaba |
|---|---|---|---|
| TPC *cfu/g* | $7{,}1 \times 10^2$ | $9{,}5 \times 10^2$ | $1{,}2 \times 10^3$ |
| Coliform *cfu/g* | $2 \times 10^1$ | $1 \times 10^1$ | $3 \times 10^1$ |
| E- Coli | - | - | - |
| Salmonella | Negative | Negative | Negative |

Meat is a source of protein that is very susceptible to microbial contamination. Although the muscles of healthy animals are not contaminated with microbes, the surface of the meat can be contaminated during several stages of slaughter and transportation (Ercolini et al., 2010). This is in accordance with Syukur (2006), report that foodstuffs of animal origin (meat, eggs, and milk) and their processed products are easily damaged and are excellent media for microbial growth. Some microbial contamination can be caused by the sanitation of equipment, workers, exposure to floor surfaces, contamination of digestive tract contents, and water use in abattoirs, and can also increase during packaging, transportation, and distribution processes. Microbial contamination of meat can occur before and after the animal is slaughtered. According to Gustiani (2009), shortly after the cattle are slaughtered, the blood is still

circulating throughout the animal's body, so using an unclean knife can cause microorganisms to enter the blood. Meat contamination can be prevented if the slaughtering process is carried out hygienically.

Based on the results of microbiological data in this study (Table 3), it was found that the highest TPC and coliform contents were in Bali beef slaughtered at Darmasaba RPH. RPH Darmasaba is a community managed RPH whose management is simple and of course the level of sanitation is still low. Based on observations in the field, slaughtering livestock on the floor and then proceeding with grounding on the floor without hanging, of course resulted in a high level of bacterial contamination. The absence of a special viscera also allows contamination to occur. It is different with the RPH Mambal and Pesanggrana which are managed by the government with more adequate facilities. In these two RPH, the garages are hung by hanging and there is already a special innards room so that contamination can be minimized. Based on the provisions set by the National Standardization Agency (BSN), the microbiological requirements for beef circulating in Indonesia are a total plate count (TPC) of 1 x 106 cfu/g, Coliform bacteria 1 x 102 cfu/g, and Escherichia coli bacteria 1 x 101 cfu/g and Salmonella were negative (SNI 7388, 2009). If you look at the data in Table 3, the microbiological quality of Bali beef at the three abattoirs has good quality because it is below the SNI threshold. So, microbiologically, the meat of the three abattoirs is still safe for consumption

## Conclusion

The physical quality of Balinese beef slaughtered at the Darmasaba RPH has the lowest physical quality compared to the Mambal and Pesanggaran abattoirs, especially on the pH and meat color variables. The chemical quality of Bali beef slaughtered at the three different abattoirs had no significant difference in water content, protein content, and ash content. The total plate count, colliform was below the SNI threshold while e-colli was not identified and salmonella was negative.

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# Spatial Distribution of Mercury Pollution in the Mempawah River Watershed, West Kalimantan – Indonesia

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## A B S T R A C T

*Mempawah River Basin (DAS) is a water resource for the people of Mempawah and Landak Regencies. The community uses the Mempawah River as the main medium for agricultural needs, plantations, and the rearing of fish for consumption. Awareness of health that comes from water with its various uses, there has been consumer anxiety when consuming air along with agricultural and fishery products that are relevant to water use in the Mempawah watershed. This phenomenon occurs because the water resources of this watershed area have been polluted by mercury as a result of unlicensed gold mining activities in its spatial extent. This research was conducted to analyze the level of mercury pollution in the river basin, due to illegal gold mining activities. The method applied was purposive sampling, through 29 water sample points located in the upstream, middle and downstream. The sample results were explained using the Atomic Absorption Spectroscopy (AAS) tool. Then, from a spatial perspective, the location of PETI activities was analyzed spatially using Spatial Dynamic Modeling Geographical Information System software with kriging interpolation techniques, to predict the distribution of mercury pollution. The results of the research show that in the middle part of the Mempawah watershed, there is mercury pollution from 0.0023mg/lt to 0.0083 mg/l and has exceeded the threshold determined by PP No. 22 of 2021. The upstream and downstream parts of the Mempawah watershed are not polluted by mercury, because the PETI activity point is only in the middle part of the Mempawah watershed. These findings provide suggestions that the allocation of Mempawah River water as the sole raw material for corporate entities and its use for growing fish communities should be more closely monitored, to avoid danger, due to the chain of heavy metal contamination in the form of Mercury.*

***Keywords---****Mempawah River, mercury pollution, mercury, pollution distribution, Watershed (DAS).*

## Introduction

Unlicensed Gold Mining Activities (PETI) are mining activities carried out by individuals, groups of communities, or lawful foundations undertaken without the permission of government agencies in accordance with the regulations of the applicable laws (Wahyudi, & Slamet 2017). PETI activities are illegal activities that have been regulated in the Mineral and Coal Mining Act No. 4 of 2009. Water pollution by Mercury occurs through small-scale gold mining, which uses the elemental type of mercury as a gold purifier in the amalgamation process. Mercury used in gold purification is disposed of in the river body, resulting in pollution of river water. Mercury pollution in the Tebaung River, Kapuas Hulu amounted to 0.0063 mg/l (Astika, 2017; Triana et al., 2012).

Mercury monitoring and evaluation as a result of PETI can be done with spatial analysis. The analysis of spatial data using the Geographic Information System (GIS) can be used to determine the spread of pollution from the point of origin of the contamination. The kriging interpolation method can be used as it gives a picture of pollution in an area as it can estimate values between data samples (Hidayat, 2020). The study aims to analyze and mapp spatially the water conditions of the Mempawah River, which is the main water source for the people in Mempawha district exposed to Mercury pollution due to gold mining

activities without permission (PETI) (Andilala, 2017; Armid & Takwir, 2020; Basmi, 1999).

## Research Method

### Location and Time of Research

The research was conducted in September 2020-January 2021 in the Hulu, middle, and suburbs of the Mempawah DAS, West Kalimantan.

### Data Collection Methods

The determination of the water sampling point is done using the purposive Sampling method with the sample collection divided according to the lower DAS section, i.e. there are 11 sample points in the lower part, 7 samplings in the middle part, and 10 samplers in the upper part (Cahyaningsih & Harsoyo, 2010; Darmono, 1995; Effendi, 2003). The sample taking of water is carried out using the grab sampler method referring to SNI 03-7016-2004 Sample Samplings Method in the framework of water quality monitoring in a river-flowing area (Loh et al., 2012; Heliani et al., 2020).

### Data Analysis Methods

### Mercury Pollution Analysis

The samples of river water that have been obtained were then analyzed in the Laboratory of the Pontianak Industry Research and Standardization Hall (ESRI, 2020; Hadi & Asiah, 2015; Harseno & Tampubolon, 2007). The analysis was carried out to measure the level of accumulated heavy metal content (Hg) due to the impact of PETI activity in the Mempaw River. Measurement of Hg levels using Indonesian National Standard SNI No. 06-2462-1991 on the method of testing of mercury levels (Hg) in water and water with cold automation spectrophotometer. Scope of testing SNI 06-2462-1991 which has a concentration range of 0.6 µg Hg/L up to 15 µgHg / L (Karssenberg, 2002; Kemp, 1992; Kristanto, 2002; Yulis 2018).

### Mercury Pollution Spatial Mapping Analysis

Sampling point coordinates are recorded by the cellular Global Positioning System (GPS) (Hylander & Goodsite, 2006; Budnik & Casteleyn, 2019). The results of chemical analysis (average sample values) are then used as input data in ArcGis 10.5. Sampling locations are integrated with water data for the creation of spatial distribution maps (Lauselang, 2019; Matějıček et al., 2003; Palar, 1994).

### DAS Mercury Pollution Analysis Down

Laboratory analysis using the AAS method is used to determine pollution values based on river water intake points (Prasasti et al., 2005; Reid, 1961; Romiyanto et al., 2015). The substantial pollution outcome in the downstream DAS will be compared with the mercury contamination threshold in PP No. 82 of 2001 on Water Quality Management and Water Pollution Control (Boening, 2000; Lin et al., 1999).

## Result and Discussion

The rainwater that falls into the DAS is divided into three sections according to the topographical height of the entire section of the DAS, i.e. the area of the top, the middle, and the latter (Fernández-Martínez et al., 2019; Li et al., 2009). The sources of rainwater falling to the DAS are flowing from the top to the bottom of DAS in Kuala Mempawah, due to the height difference of each section of DAS. The DAS has an area of 3.260 km2 whose use in the land is dominated by the fields, plantations, and plantations mixed from various horticultural commodities such as coconut, palm oil, tomatoes, onions, peppers, to fruits. The use of the water space is used for the cultivation of fish breeding in Keramba Jaring Apung (KJA), and as a raw material for drinking water treatment by the Drinking Water District Company, Mempawah District (Suharyadi, 2004; Widodo, 2008; Widowati et al., 2008; Wismarini & Khristianto, 2016). The results of land use mapping are known, that the ancient and central areas are occupied by communities with low density, with locus only areas that are close to the body of the river. This is due to historic factors of ease of accessibility and use of water for various provisions by the community (Sancayaningsih et al., 2010; Setiabudi et al., 2007; Subanri, 2008).

Described, the results of laboratory analysis using the AAS method on the sample of water from the back and bottom of DAS Mempah showed Mercury's condition did not pass the quality standards already specified in PP No. 82 of 2001. While the analysis of the mercury content of the waters of DAS Mempah below the central part marked with traces of former PETI activities in the land, there are areas whose waters are contaminated with Mercury. Map of land use of DAS Down, can be seen in Figure 1:

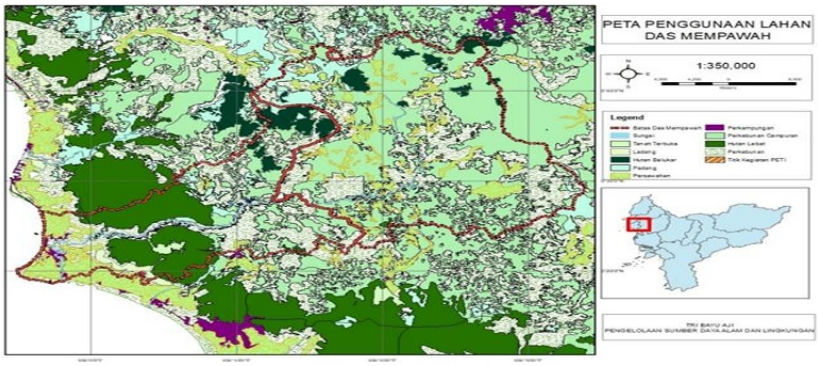


Figure 1. Map of DAS land meltdown

Information about the results of Mercury content analysis in the Hulu Bottom DAS section can be found in Table 1:

Table 1
Results of Mercury Content Analysis of DAS

| No | Latitude | Longitude | Mercury pollution (mg/lt) | Description |
|---|---|---|---|---|
| 1 | 0,466438 | 109,333777 | 0,0002 | Not contaminated |
| 2 | 0,479653 | 109,345013 | 0,0002 | Not contaminated |
| 3 | 0,485582 | 109,356767 | 0,0004 | Not contaminated |
| 4 | 0,507034 | 109,370622 | 0,0002 | Not contaminated |
| 5 | 0,513923 | 109,376397 | 0,0002 | Not contaminated |
| 6 | 0,554922 | 109,375493 | 0,0002 | Not contaminated |
| 7 | 0,566886 | 109,.36343 | 0,0003 | Not contaminated |
| 8 | 0,577136 | 109,348644 | 0,0002 | Not contaminated |
| 8 | 0,606381 | 109,342725 | 0,0002 | Not contaminated |
| 10 | 0,612347 | 109,332827 | 0,0002 | Not contaminated |

Lower Hulu is a mountainous area that is used for various land allocations, mainly as a planting area, food crops farming, and annual horticulture, as well as a population settlement area in the forests of limited production (Jaiswal et al., 2015; Das et al., 2019). At the top of the bottom of the DAS there is a sample that has a greater mercury content than the other sample from this section of DAS, i.e. 0,0004 mg/l. This is supposed to be due to a natural cycle in nature that naturally forms mercure. Furthermore, the bottom of the DAS is dominated by Sawit plantations and mixed plantations, so the use of mercury-containing disinfectants can be the cause of the Mercury content in the sample points. Mercury can spread in the environment from agricultural material (Alfian, 2006).

In the suburbs of the Mempawah district, which is an urban area, 12 water samples were collected. Laboratory results show the content of Mercury as follows:

Table 2
Results of mercury content analysis of DAS

| No | Latitude | Longitude | Mercury pollution (mgl-1) | Description |
|---|---|---|---|---|
| 1 | 0,324 | 108,969 | 0,0002 | Not contaminated |
| 2 | 0,3653 | 108,962887 | 0,0002 | Not contaminated |
| 3 | 0,388039 | 108,96603 | 0,0002 | Not contaminated |
| 4 | 0,389074 | 108,967789 | 0,0002 | Not contaminated |
| 5 | 0,38568 | 108,969039 | 0,0002 | Not contaminated |
| 6 | 0,381626 | 108,979168 | 0,0002 | Not contaminated |
| 7 | 0,390992 | 108,99839 | 0,0002 | Not contaminated |
| 8 | 0,393 | 108,006 | 0,0002 | Not contaminated |
| 9 | 0,398176 | 109,005514 | 0,0002 | Not contaminated |
| 10 | 0,401353 | 109,014525 | 0,0002 | Not contaminated |
| 11 | 0,401353 | 109,014525 | 0,0002 | Not contaminated |
| 12 | 0,402031 | 109,024816 | 0,0002 | Not contaminated |

The laboratory results showed that the waters in the Hilir section of the DAS are not contaminated with Mercury. This is indicated with mercury content not exceeding the threshold of the standard quality set by the Act No. 82 of 2001. The area is covered by the density of residential and business areas, as well as fishing ports with various attributes of community activities, along with its economic activity, which is based on the water resources that exist in the body of the river DAS Mempawah. This density occurs as a consequence, the area is the capital of the district.

A sample of DAS water at the bottom of the middle section was taken from seven water samples. Identification and mercury content of such samples can be seen in Table 3:

Table 3
Results of DNA Mercury Analysis Downtown

| No | Latitude | Longitude | Mercury content (mg/l) | Description |
|---|---|---|---|---|
| 1 | 0,427 | 109,092 | 0,0002 | Not contaminated |
| 2 | 0,427 | 109,093 | 0,0002 | Not contaminated |
| 3 | 0,419 | 109,094 | 0,0002 | Not contaminated |
| 4 | 0,455988 | 109,178845 | 0,0083 | Polluted |
| 5 | 0,453 | 109,182 | 0,002 | Polluted |
| 6 | 0,456 | 109,19 | 0,0023 | Polluted |
| 7 | 0,458 | 109,198 | 0,0002 | Not contaminated |

The results of the AAS test showed that in the middle area of the DAS below there were contaminated samples of Mercury with mercury values ranging from 0,0002 mg/L to 0.0083 mg/ L located at the samples points 15, 16 and 17. The analysis of the sample in the laboratory indicated that the mercure content exceeded the threshold of raw quality specified in PP No. 82 Year 2001. The central part of the Lower D.A. is dominated by plantation areas, mixed plantations, and limited production forests. Land usage in the middle of the Lower D.A. refers to Figure 2:

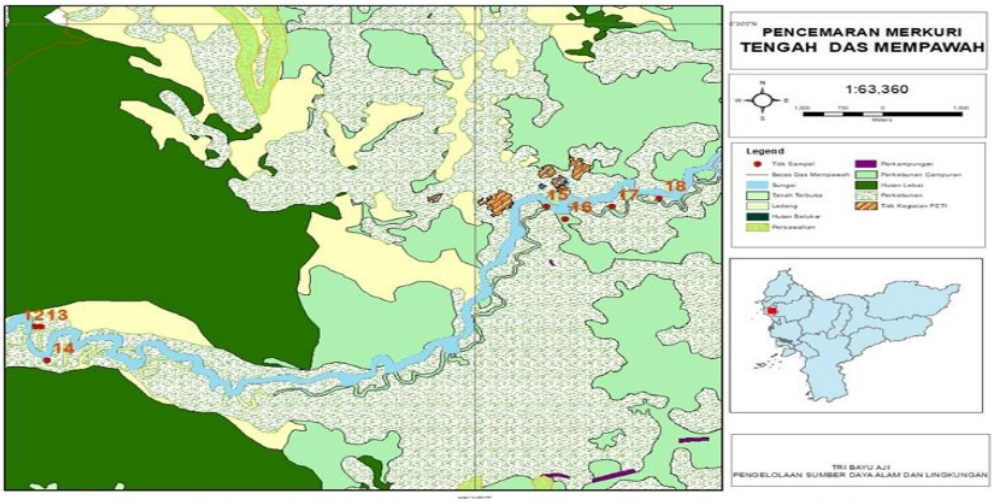


Figure 2. Sample Point Map and Land Usage Down Downtown DAS

The pollution at the sampling point number 15, 16, and 17 is due to the existence of several PETI activity points. PETI activities in the middle area of the Mempawah DAS have an area of 54 Ha which is divided by 7 PETI action points. The largest Peti activity point is 21.91 Ha.

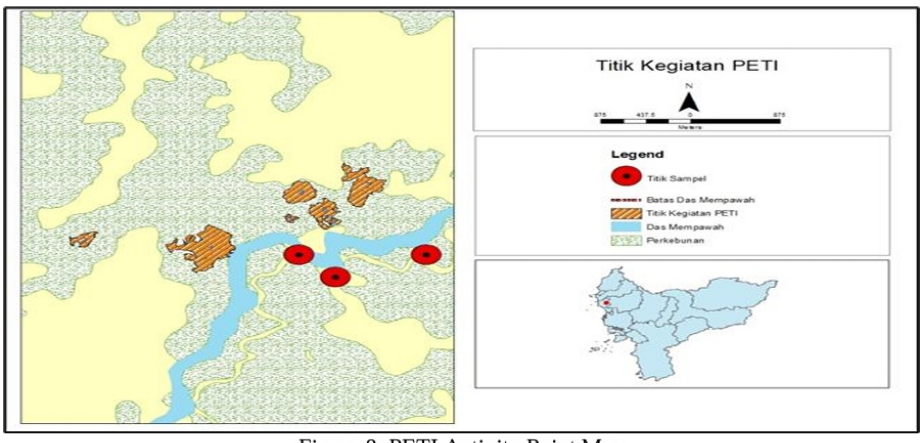


Figure 3. PETI Activity Point Map

The PETI activity area is the main source of mercury pollution in the Mempawah DAS. The results of the map analysis are shown in Figure 4:

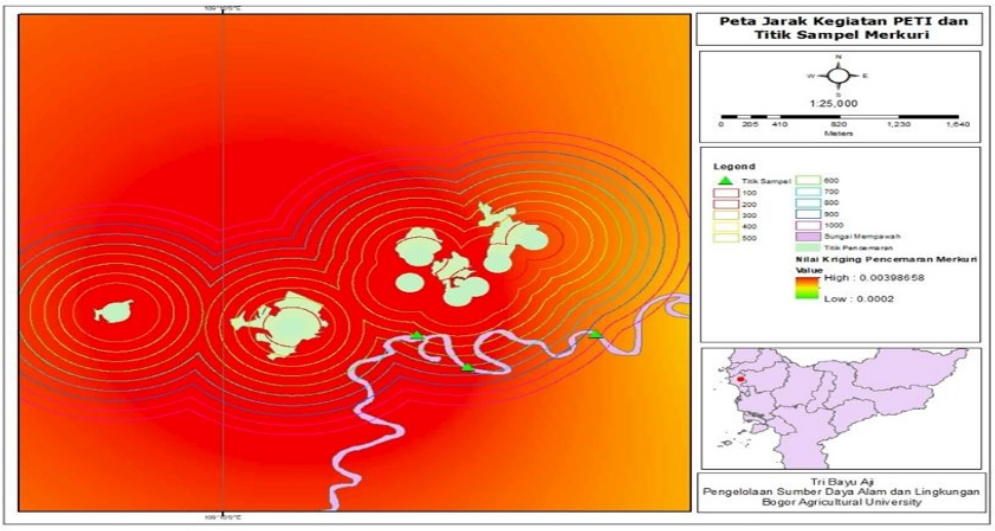


Figure 4. PETI activity distance map and sample point

The distribution of Mercury around the River Mempawah is near the highest point of PETI activity in a radius of about 400 M to 800 M. At the 400 M radius of the PETI point of activity, the mercury content is 0.0083 mg/l, then at the 700 M radius the mercure content is 0,002 mg/ l, while at the 800 Meter radius the content of mercure is 0.023 mg/L. These heavy metals have characteristics that are difficult to describe by the environment. The heavy metals that enter the water body will settle and accumulate in the sediment and part of it will enter the living organisms. (Shukla et al., 2007). The results of kriging interpolation are presented in Figure 5 below:

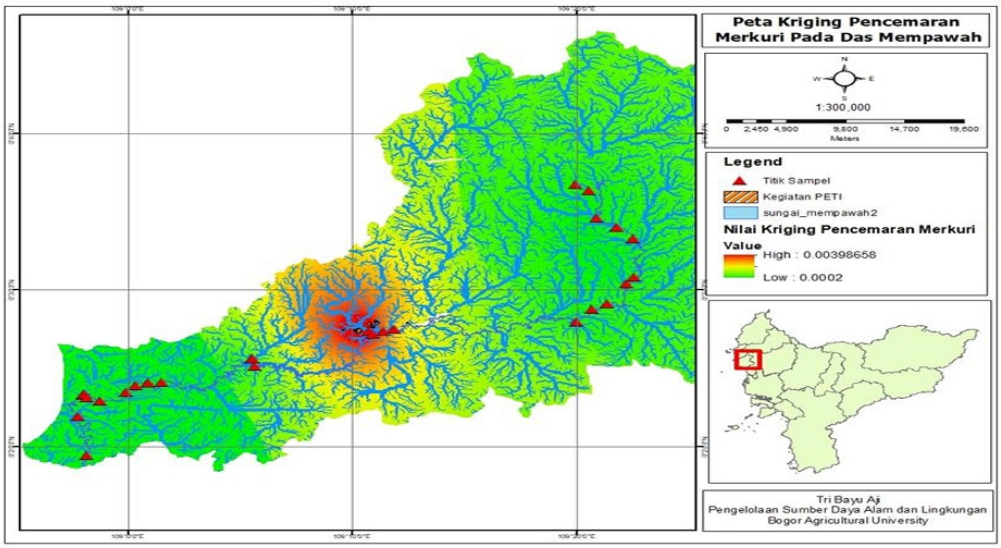


Figure 5. Mercury Pollution Circulation Map on DAS Down

The results of the mapping carried out using the kriging interpolation method showed the color differences of each area of the study according to the intensity of Mercury concentration from the lowest to the highest in the sampling area which would ultimately make it easier to read and understand the map. The map in Figure 5 shows the distribution of Mercury classified by color gradients from green to red. The green color indicates an area that is not exposed to mercury contamination with a mercure content of 0,0002 mg/l. The area covers the downstream of the Downstream and the upper edge of the Upperstream. Mercury originating from the amalgamation process has high concentrations so that its

mobility in the water bodies is reduced Gerson et al. (2018), thus resulting in high mercury concentrations in the area of PETI activity. Mercury derived from the amalgamation process in PETI activities is discharged into the environment with high concentrations and can damage the environment. Mercury entering the water body will accumulate in the soil. Mercury, which is in the aquatic environment as a result of human activity, has a limited spread, because it is a liquid heavy metal with a larger weight than water, so that its concentration in the water body is not far from the point of contamination. The pollutants that are in the waters are affected by the speed of the flow of the river, which, as the flow is slowed down, leads to the accumulation of the pollutant in one contaminated area (Yulianti et al., 2018). The topography of the Lower D.A. affects the flow rate of river currents in the area. The top area of the Mempawah DAS is an area that has a higher altitude than the middle area and is below the DAS, so Mercury is not detected in the top area. Pollution in river water is affected by water slope (Bugis, 2003). This indicates that there is a huge difference in the concentration of Mercury in the three parts of the Downstream.

The mercury used in the amalgamation process will be discharged into the river body and will survive in the environment and accumulate in the food chain in the form of Mercury Methyl. This Merkury methyl contaminates and damages organisms by entering the food supply chain through plankton (Lino et al., 2019). Plankton, which consists of phytoplankton and zooplancton, can absorb mercury directly from the water body, compared to zooplanton, absorbing more Mercury in the aquatic body than it does to the phyto-plankton (Fisher & Hook, 2002; Tsui & Wang, 2004). This will affect the health of the people who depend on their daily water requirements and also for the community who consume the fish from this Downfall DAS.

The PDAM district of Mempawah uses its own water from the DAS to use the raw water that will eventually be consumed by the community. In this study, samples were also taken from the Wastewater Treatment Plant (IPAL) and water distribution PDAM that showed mercury contamination of 0.0024 mg/L and 0.0039mg/L. Mercury pollution in drinking water management processes is very potentially hazardous to public health. According to the Act No. 82 of 2001 on the Management of Water Quality and Control of Water Pollution, there is a classification of water quality established in 4 classes, where the first class used for raw drinking water with a raw quality content of Mercury exceeding 0,001 mg/L. This shows that water on the DAS Down at some points of absorption can harm the community that uses it. In the same law on the classification on water quality in the third class that is used for the cultivation of freshwater fish, farms, water for irrigation of plants also indicates that the water on DAS Down cannot be used for freshwater fishing. Mercury accumulated in the water will be absorbed by aquatic organisms. Heavy metals in the water are the cause of damage to community structures, genes, food tissues, behavior, and physiology of aquatic organisms (Yazhini et al., 2018). Heavy metal such as Mercury in the waters will enter the body of aquatics and accumulate in the organs of the organism. In a study conducted by Haque et al. (2019); Selvanthan et al. (2013); Sambo et al. (2020), suggested that fish exposed to Mercury have damage to the insects, because the insect organs are organs that have been in contact with the inserts in toxic environments. The liver's organs are very susceptible to exposure to Mercury because the liver is the primary target organ of toxic substances through liver portal veins. (Bakos et al., 2019).

**Conclusion**

The results of the analysis of Mercury pollution in the waters of the D.A.P.Bow showed that there are areas where the water source is contaminated with Mercure, the level of which exceeds the threshold established in PP No. 82 of 2001, on Water Quality Management and Control of Water Pollution. The fact of this mercury contamination was found in the central area of DASBow with a mercure content, between 0,0002 mg/L – 0,0083 mg/ L. The results from the spatial mapping of SIG stated, that the distribution of mercure contamination in the DASPowers showed the presence of Mercure content around the site of the PETI activity with the mercy content exceeding the limit, of 0.0023 mg/l to a distance of 800 Meters. This fact gives a signal, that the management of water resources with its use, such as for the fishing activities carried out by the community along the Mempawah River and as a raw material of Water Treatment by the Company of the District of Drinking Water of Mempowah District, need to get special treatment, so that its existence does not endanger public health in the various areas affected on the space referred to in this study.

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