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VARIATIONS IN HORN TYPE, HORN ORIENTATION, AND COAT COLOR OF THE TARO WHITE CATTLE

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ABSTRACT

Taro white cattle is Bali germplasm, found only in Gianyar Regency, Bali Province that has not much been identified. This study was undertaken to identify variation of quantitative traits i.e. coat color, horn type and orientation, and their distributions in Taro white cattle population. Physical assessment of 44 Taro white cattle consisted of 23 males and 21 females were photographed for their horn type and variation, and coat color using digital camera. Data of the physical assessment were analysed by qualitative description. Results of physical assessment revealed that there 8 variations of horn type i.e. bajeg, pendang, cono, manggulgangsa, anoa, srinata, subeng, and asimetris where the first five were similar to horn orientation of Bali cattle. Of the 23 males, the cono was found in 21 males (91%) and pedang was found in 2 males (9%). Of the 21 females, 7 horn types were found i.e. 57% cono, 14% bajeg, 9% manggulgangsa, 5% anoa, 5% srinata, 5% subeng, and 5% asimetrical horns. Both females and males had more cono horns i.e. 57% and 91%, respectively. All calves were born white coat color and it turned to be pinky white, ivory

white and sudamala. Sudamala was only found in males but not all the males had sudamala. The obtained results are considered as the first values to be published for the Taro white cattle characteristic. In summary, Taro white cattle had 4 coat colors and 8 horn types where 5 of them were similar to the horn types of Bali cattle.

KEYWORDS: Taro white cattle, Bali germplasm, physical assessment, horn type, coat color.

INTRODUCTION

Indonesia is rich in various animal and plant germplasms. Germplasm conservation is the most successful method to conserve the genetic traits of endangered and commercially valuable species (FAO, 2012). Challenges faced by germplasms or genetic sources in the world particularly in Indonesia due to the increasing demand for livestock or livestock products as increasing of human population while the total number of germplasms has been gradually decreasing (FAO, 2012). The decreasing is caused by local breeds are crossed with other breeds for increasing production reasons (Cardellino, 2006; Zhang *et al.*, 2018). Therefore, genetic sources or germplasms have to be managed well by characterizing them (Dorji and Gyeltshen, 2014), where identification is the first step (Soro *et al.*, 2015) to identify the breeds and their performance in certain conditions. FAO (2012) convinced that characterizing is important to identify genetic sources as well as to plan their rearing management. Characterizing, inventarizing and monitoring of livestock genetic are important management to ensure their sustainability (Mekonnen and Meseret, 2020).

Indonesia particularly Bali Province has been known having germplasms i.e. exotic Bali cattle that has been maintained for their pure breed in Bali Province (Anonymous, 2004; 2017). However, it has not been known much about Bali germplasm of Taro white cattle that are reared only in Taro Kaja Village, Tegallalang District of Gianyar Regency (Heryani *et al.*, 2016). Epigraphs revealed that the Taro white cattle were Siwa God's transportation that was brought by Markandeya Rsi from east. However, research had not revealed yet regarding their original place and how the white cattle exist in Bali Province particularly in Taro Village, Gianyar Regency. Although little information about the original place of Taro white cattle, they are reared due to Balinese Hindu particularly society in Taro Village considered that they are sacred and used in Bali Hindu ceremony.

In 1965, the numbers of Taro white cattle population were more than 100 (Yasa *et al*, 2015). Due to the land function has been changed, and less land was available for the Taro white cattle; Taro villagers reared by tighing up them under trees. This rearing system, however, reduced the number of Taro white cattle population to be 25 in 2011 (Suarna, 2014). Yasa *et al.* (2015) reported that in 2014 Taro white cattle population was only 34 consisted of 16 males, 12 productive females, 3 male and 3 female calves and then in 2017, their population increased to be 51.

Taro white cattle had unique genetic potential that although they were in critical number of population, they survived in limited environment (Heryani *et al.*, 2016). In critical number of population and in limited environment, animals were involved in inbreeding. Peacock, 1996; Jansen and Burg, 2004 also reported that small flock sizes of small ruminants may lead to inbreeding, particularly when the numbers of productive males were small, had high dominance order, or the males were used for a long time. This inbreeding system caused population or breed lost their heterozigosity and then the breed's characteristic changed (Gwaza *et al*., 2018). Qualitative characteristic known also affected by the presence of genetic dilusive through the unmanaged crossbreeding and the high level of inbreeding system thus increased allelic frequency differensiation and genetic divergency (Gwaza and Momoh, 2016).

Morphological characteristic of Taro white cattle showed the body size that was similar to of the Bali cattle i.e. the body length, body weigth, chest width, chest diameter, hip height, head length and head width that were different between male and female of Taro white cattle. Some of morphological characters of Taro white cattle were smaller compared to Bali cattle particularly in body length and height of withers (Heryani *et al.*, 2016).

Qualitative characters can be used to classify and indentify animal population (Chamdi, 2005; Utomo *et al*. 2012). Variation in characteristic observed such as coat color, face profile, and horn type and horn orientation helped in interspesiphic variation among breeds in animal population (Salako, 2013). Little has been reported regarding phenotific characteristic of Taro white cattle; however, there is no doubt about the Taro white cattle population that had experienced the environmental stress and so had decreased their critical number of population. The objective of this study was to analyse the variations of qualitative traits i.e. coat color, horn type, horn orientation and their distribution in the 23 male and 21 female Taro white cattle population conserved in Taro Village in 2020.

MATERIALS AND METHODS

Study sites

This study was conducted in Taro white cattle conservation under the supervision of *"Yayasan Lembu Putih Taro"*, non profited institution in Taro Kaja Village, Tegallalang District, and Gianyar Regency. Taro Village is situated between $8^0 19' 4''$ to $8^0 29' 38''$ south and $115^0 15' 18.8''$ to $115^0 19' 40.8''$ east in height from 600 – 750 m a.s.l. Taro Village experiences arrange of temperatures between 19 and 27.5^{0}C, relative humidity of 67%, annual average rainfall of 959.2 mm and average wind velocity of 3 to 9 knots (Bali Meteorology Biro 2019) (www.bmkg.go.id, ok).

Experimental animals and their management

Twenty three male and twenty one female Taro white cattle that are reared intensively in colony houses and fed with grasses twice daily were used in this study. Data collection was conducted in February to March 2020. During data collection, the total population of Taro white cattle was 59 consisted of 29 males and 30 females. Of the 59 Taro white cattle, 8 newly born calves had I_0, 9 cattle had I_1, 7 cattle had I_2, 9 cattle had I_3, and 26 cattle had I_4. Regular visiting for health check up was done by a vet.

Experimental procedure and materials used

Parameters measured

Physical assessment of body coat color, horn type, and horn orientation of individuals were taken using digital camera and their distributions were assessed. Orientation and horn type of Bali cattle studied by Batan (2002), Ris *et al*. (2012) and Nealma *et al*. (2014) were used as guidance in this study. Horns were observed carefully and then categorised by type and orientation. The presence of coat color, horn type and horn orientation was calculated for both in male and female Taro white cattle.

Data collection and analysis

Data collection i.e. type and orientation of horn and coat color were analysed by qualitative description and the presence of the data collection was calculated in percentage based on their frequency distribution. Results are presented in figures and tables.

RESULTS AND DISCUSSION

This study revealed that both the 23 male and 21 female Taro white cattle have horns. The Taro white calves grow horns at the first time at 3 to 4 months; however, the horns in females grow slower than of those of male. In general, the Taro white cattle have warp and straight horn orientations as the Bali cattle do. This result was confirmed by Iype *et al.* (2016) and Jain *et al.* (2018) who reported that Bali cattle have warp and straight horn orientations. The horn orientation in Taro white cattle is unique. The Balinese named the horn orientations based on the tools or equipments that were used daily. For instance, when the orientation is straight and it looks like a *gender* (Balinese traditional music instrument) beater, therefore, they named its orientation as manggulgangsa. Results showed 8 horn orientations in 23 male and 21 female Taro white cattle conserved in Taro Village in 2020 (Table 1) that three of them were straight pendang, straight cono and straight anoa, while the rest five were warp bajeg, warp mangulgangsa, warp srinata, warp subeng and warp asymmetric. This result was supported by Batan (2002); Ris *et al*. (2012) and Nealma *et al*. (2014) who observed that horn orientations in Taro white cattle are similar to those of Bali cattle. Unlike the Bali cattle, both the male and female Taro white cattle did not have congklok horn warp orientation (Table 1).

Table 1: Horn type and horn orientation were in 23 male and 21 female Taro white cattle conserved in Taro Village in 2020.

Horn type	Horn orientation	Total population	Percentage
Pendang	Type of horn that grows relatively **straight** to other side	2	4.5
Cono	Type of horn grows **straightly** toward backside of head.	33	75.0
Anoa	Type of horn that grows **straight** toward upside without warps.	1	2.3
Bajeg	Type of horn that grows towards upside and then **warps** toward inside	3	6.8
Manggulgangsa	Type of horn that grows linear with forehead toward backside, **warps** toward downside and its tip grows toward inside.	2	4.5
Srinata	Its **warp** orientation is similar to the jewellery that commonly used on the Balinese bride's forehead	1	2.3
Subeng	Its **warp** orientation is similar to Balinese dancers' earrings	1	2.3
asymmetric	Type of horn that its orientation is different from the six types of horn above.	1	2.3
	Total	44	100.0

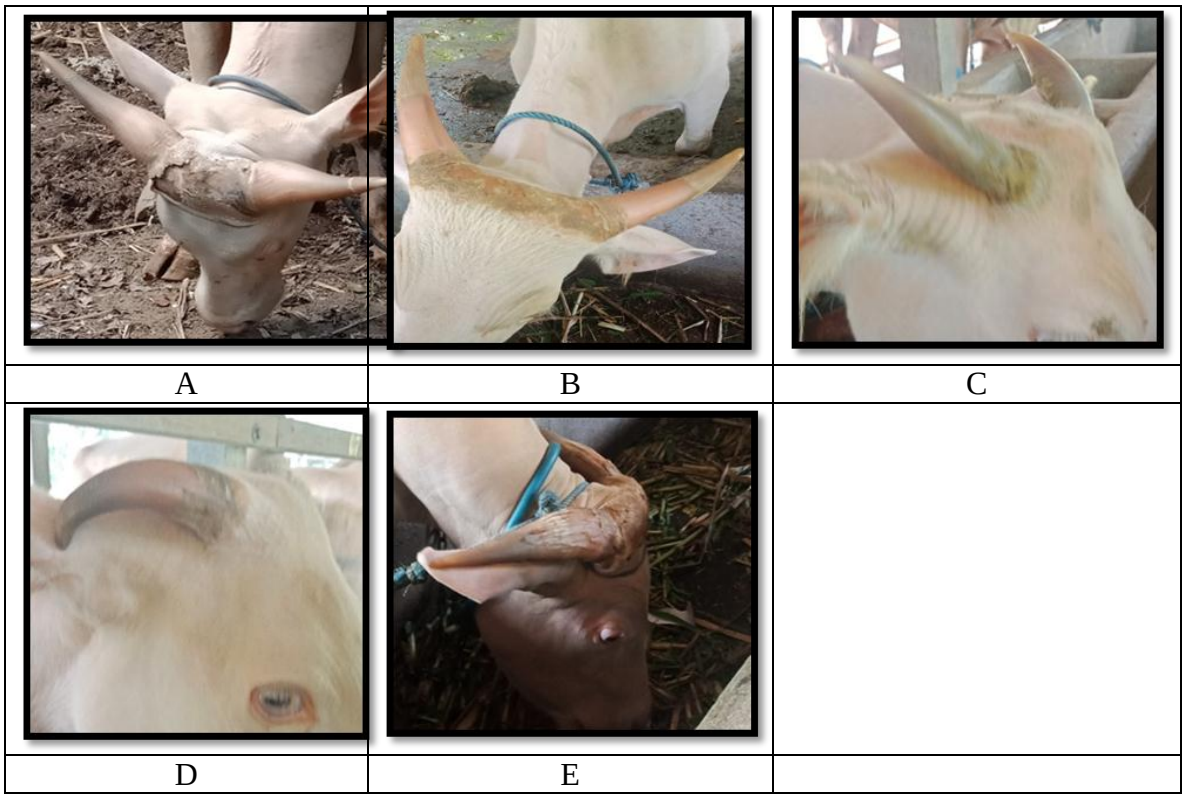

Fig. 1: Horn type in 23 male and 21 female Taro white cattle conserved in Taro Village in 2020. A. Pendang; B. Bajeg; C.Anoa; D. Manggulgangsa; E. Cono.

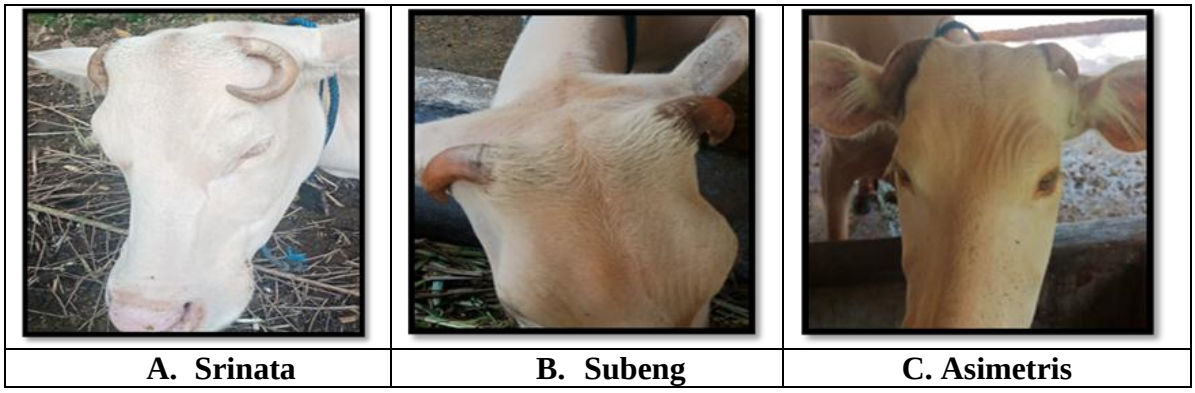

Fig 2: The differences of horn types: Srinata (A), Subeng (B), and Asimetris (C) in 23 male and 21 female Taro white cattle conserved in Taro Village in 2020.

Beside all the horn type and orientation mentioned above, this study revealed other horn type and horn orientation that had never been reported found in Bali cattle (Fig. 2). Its warp orientation is similar to the jewellery that commonly used on the Balinese bride's forehead, so Balinese named its orientation as srinata. Another orientation looks alike *subeng* (Balinese dancers' earrings) and named its orientation as subeng. Another else orientation looks alike

asymmetric where their left and right side horn grew differently in size and form where in Bali cattle this asymmetrical horns considered as abnormal (Nealma *et al.,* 2014).

This result revealed that not all type and orientation found in male Taro white cattle were also found in females. In general, all the horn type and orientation in Taro white cattle were also found in Bali cattle, although in Bali cattle the srinata, subeng and assymetric were considered as abnormal. However, the horns in Taro white cattle had brighter than of Bali cattle. The presence of horn type and horn orientations is presented in Table 2. Male Taro white cattle had lesser horn type and horn orientation i.e. pendang and cono than female did i.e. cono, anoa, bajeg, manggulgangsa, srinata, subeng and asymmetric. Both male and female Taro white cattle had 47.7% and 27.3% cono, respectively (Table 2). This result also revealed that Taro white cattle did not have congklok horns that are common found in Bali Cattle. Bali cattle had congklok particularly in males that they look good smooth while in female Bali cattle commonly had more manggulgangsa (Payne and Rollinson, 1973). Variation of horn type and horn orientation of Taro white cattle is presented in Fig. 2 and the presence of them is presented in Table 1.

Horn type and orientation are quantitative traits that are used to identify cattle breed. For certain needs of the farmers, the horn type and orientation were always modified that started modifiying in early as 3-4 months of age of the calves when their horns started growing. The modification by tighing up the two horns for warp orientations. Tips of the two horns were put closer and formed circle horns. The goal of modification was to present the special horn orientation, and made it easier to identify the cattle by the owners as well as to protect the cattle from endager other cattle or the owners. This result was supported by Terefe *et al.* (2015) who reported that the horn modifications brought safetiness particularly when they were milked the cows, blood taking, or gave medication. In Bali Province, Bali cattle farmers had preferences of horn type and orientation and they usually had higher prices particularly when the Bali cattle were used as sacred offering animal in Balinese Hindu ceremony or Eid Qurban celebration by Muslims. This result was confirmed by Ries *et al.* (2012) who reported that Muslims and Balinese Hindu preferred horned cattle particularly male cattle and had higher prices.

This study revealed that the limited number of population of Taro white cattle population conserved in Taro Village were not purchased but considered as sacred animals that have to be treated as human beings and no horn selection system applied. This caused the Taro white

cattle generally had all the 8 horn types and orientations. However, this study did not reveal other factors than sex affecting the horn type and orientation in Taro white cattle. Taro white cattle had more cono both in male and female while Bali cattle had more congklok but was not found in Taro white cattle.

Table 2: The presence of horn type and horn orientation in 23 male and 21 female Taro white cattle conserved in Taro Village in 2020.

No.	Variation on horn type	Male (%)	Female (%)	Total (%)
1	Pendang	4.5	0.0	4.5
2	Cono	47.7	27.3	75.0
3	Anoa	0.0	2.3	2.3
4	Bajeg	0.0	6.8	6.8
5	Manggulgangsa	0.0	4.5	4.5
6	Srinata	0.0	2.3	2.3
7	Subeng	0.0	2.3	2.3
8	asymmetric	0.0	2.3	2.3
9	Congklok	0.0	0.0	0.0
	Total	52.2	47.8	100.0

Fig. 3: Four variations in coat color i.e white, pinky white, ivory white and sudamala of 23 male and 21 female Taro white cattle conserved in Taro Village in 2020.

(PLEASE CHANGE THEM TO BE WHITE, PINKY WHITE, and IVORY WHITE, darling jhegheg!!)

Fig. 3: Four variations in coat color i.e white, pinky white, ivory white and sudamala of 23 male and 21 female Taro white cattle conserved in Taro Village in 2020.

This study generated new important and detail information on four coat color variations i.e. white, pinky white, ivory white and sudamala (Fig. 3). The presence of the color differences particularly when the female and male Taro white cattle had sexual maturity when they were

aged of 8-9 months. During data collection, there were 8 newly born calves with white coat color and all physical characteristic of them was recorded. This white color gradually changed when they grew older and when they achieved sexual maturity their coat color gradually changed to be ivory white, pinky white or sudamala. This study generated important information that the coat color changes from clear white to be pinky white and ivory white occurred in both sexes but the sudamala only occurred in male Taro white cattle (Table 3). However, this study did not present how these color changes occurred.

The last coat color change is similar to the coat color change in Bali cattle. This result was confirmed by Hardjosubroto and Astuti (1993); Hardjosubroto (1994) and Yuni Erlita (2016) who reported that the terracotta red browny gradually changed to be black only occurred in male Bali cattle that achieved their sexual maturity. The differences of coat color changes between Taro white cattle and Bali cattle that these occurred only in male Bali cattle that were not castrated; while not all male Taro white calves have sudamala when they achieved their sexual maturity. The presence of sudamala in Taro white cattle population was 6.8% in male Taro white cattle whereas no female Taro white cattle had sudamala. The common coat color in both male and female Taro white cattle were 25.0% ivory white both for males and females. Pinky white was found more in females i.e. 22.7% while in males was 20.5%.

Table 3: The presences of coat color in 23 mature male and 21 mature female Taro white cattle that were conserved in Taro Village in 2020.

Variation of coat color	Male (%)	Female (%)	Total (%)
Pinky white	20.5	22.7	43.2
Ivory white	25.0	25.0	50.0
Sudamala	6.8	0.0	6.8
Total	52.3	47.7	100.0

Coat color is exterior characteristic that is easy to be identified the cattle breeds. In the last two centuries, some classifications have been improved to identify cattle breeds i.e. coat color, horn size, scull type, and predicted original geographical sites, and their combinations. Coat color and coat pattern are clear classification and identification of breeds even for non scholar people. Charateristic in coat color was considered the pure genetic and relevant for breed "branding" (Felius *et al.*, 2011). Important role of coat color and coat pattern reflex in some breed name and become key point for classification. For instance, Taro white cattle have white color and originally came from Taro Village.

In general, coat color in cattle and all mammals occurred due to the presence or the absency melanin in skin or body coat. Coat color in cattle is largely dictated by polimorfisme in MC1R genes reseptor melanocortin 1 in cromosome βTA 18. Therefore, MC1R gene is the major gene dictates coat color (Han *et al.*, 2011; Benalcázar *et al.*, 2014). In cattle, genes that coded melanocortin 1 (MC1R) receptor had been known as the major identification between two pigments of coat color i.e. eumelanine that has role for the presence of black pigment and phaeomelanine that has role for the presenceof red pigment (Gutiérrez-Gil *et al.*, 2007; Dorshorst *et al.*, 2015). The coat color expression was depended on the proportion of eumelanine and pheomelanine, the synthesis of both pigments affected by MC1R genes that stimulated hormones involving in skin and coat color regulations of mammals including cattle (Lightner, 2008). The role of these genes was to control what type of melanine would be produced. Mutation on MC1R genes had proven to affect coat color in some large mammals, including some species of domestical mammals like cattle (Klungland *et al.*, 1995 and Rees, 2000). Based on the coat color variation occurred in Taro white cattle, it is highly required to do further tracking for identification variation of the MC1R gene.

SUMMARY

In summary, Taro white cattle revealed 4 coat colors and 8 horn types where 5 of them were similar to the horn types of Bali cattle. Taro white cattle had 8 variations of horn type i.e. bajeg, pendang, cono, manggulgangsa, anoa, srinata, subeng, and asimetris where the first five were similar to horn orientation of Bali cattle. Female Taro white cattle had bajeg, cono, manggulgangsa and anoa horn types, whereas males only had cono and pendang ones. Taro white cattle also had srinata and subeng horn types that both are in Bali cattle categorized as abnormal horn types. Both females and males had more cono horns i.e. 57% and 91%, respectively.

Coat color variations of Taro white cattle were pinky white, ivory white and sudamala. Sudamala color was only found in male Taro white cattle but not all the males had sudamala. The obtained results are considered as the first values to be published for the Taro white cattle characteristic.

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