Eco. Env. & Cons. 28 (3) : 2022; pp. (1087-1093)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03.001

Comparison of Occlusal Molar Tooth Width of the Etawa Crossbreed Goat

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(Received 10 October, 2021; Accepted 12 November, 2021)

ABSTRACT

This study aims to identify the molars based on the width of the occlusal plane. The study was designed using a group design. The object of the study was the lower jaw bone (os mandibula) of CE goats aged three to four years without distinguishing gender. Measurements were also made on the maxillary molars (maxilla) from several skulls without mandibles of 14 each. Measurements were made on one side of the mandible (mandibular) or maxilla (maxilla) assuming symmetry. Measurements were done using a caliper. The target measured was the largest total width of the crowns of the I, 2, and 3 molars (MMb11, MMb12; MMb21, MMb22, and MMb31, MMb32). The measurement data are recorded, tabulated, and presented in the form of mean and standard deviation. Size differences between molar width, molar notch, and molar plane were analyzed by two-way analysis of variance without interaction. The difference in width is significant if the test results have an error probability of less than five percent. If the test results are significant, it is tested with Duncan to see the difference in the pair at the five percent level. Conclusion, it was found that there was no difference in the indentation width between the molars, five of the fourteen molars examined, M1 showed no crypts.

Key words : *Food production, Occlusal molar, Etawa crossbreed goat***,** *Os mandibula*

Introduction

Etawa crossbreed goat (CE) is a type of goat that is widely bred in Indonesia. The CE goat is the result of a cross between the Kacang goat (a native Indonesian goat) and the Etawa goat, which is a type of Indian goat imported to Indonesia (Rochijan, 2018). Teeth are an important part of the digestive system. Teeth have the function of breaking down food before swallowing. Anatomically, the teeth are divided into two parts. First, the root canal, a part that is embedded in the jawbone. The second is the crown, the part that protrudes from the jawbone. The root and crown of the tooth are connected by the neck/dental cervix. The crown is covered by enamel, which is a hard crystalline network (Bergqvist, 2003).

Age has an important meaning in goat farming both for reproductive purposes and other management such as feed or ready-to-sell age. Like other ruminants, the age estimation of CE goats uses incisor dating as a reference. This kind of determination is useful if the age of the goat does not exceed four years. Another possibility, although rarely used, is age estimation using the molars. Teeth, including molars, in the field of archeology, are the indicator of the species in question (Min-Kyu, 2017). The molars consist of premolars and molars. Goat molars are three to four pairs. The medial plane of the molars is called the lingual plane because it faces the tongue. The lingual plane of the maxillary molars is more in line with the palatal plane because this plane is facing the palate. The buccal plane is facing the cheek. Both the distal and buccal planes appear as two triangles with a higher apex in the lingual plane. The median plane is the plane that faces the lips and the opposite plane to the direction of the lips is called the distal plane. The occlusal plane is facing the same molars but located opposite each others (Laffan, 2018). Both planes are the part where the food is crushed. The occlusal plane consists of two front and backplanes (mesial plane and distal plane) and each plane is divided into two planes, the inner plane (lingual plane) and the outer plane (buccal plane). The surface of both the lingual and buccal planes decreases so that it appears as a cleft resembling a lip. In general, goat molars are characterized by a caprine pillar (Halstead and Collins, 2002). The three molars are generally similar in shape, but metrically different, especially in the occlusal plane. The estimated difference in molar metric metrics is due to feed crushing activities.This study aims to identify the molars based on the width of the occlusal plane.

Materials and Methods

The study was designed using a group design. The object of the study was the lower jaw bone (os mandibula) of CE goats aged three to four years without distinguishing gender. Measurements were also made on the maxillary molars (maxilla) from several skulls without mandibles of 14 each. All bones belong to the Division of Veterinary Anatomy Laboratory of the Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya. Measurements were made on one side of the mandible (mandibular) or maxilla (maxilla) assuming symmetry (Casanova *et al.,* 2018).

Methods

Measurement using a caliper. The target measured was the largest total width of the crowns of the I, 2, and 3 molars (MMb11, MMb12; MMb21, MMb22, and MMb31, MMb32). The MMb represents the mandibular molars. The first number after the letter MMb indicates the order of the molars while the next number indicates the measured plane (1 = mesial plane, 2 = distal plane). Width measurements were also carried out on the buccal series plane which included the mesial buccal plane of the mandibular molars(BBMMMb) and the buccal distal mandibular molar planes (BBDMMb) of each molar tooth. The mesial lingual plane width of the mandibular molar (BLMMMb) and the lingual distal mandibular molar width (BLDMMb) were obtained indirectly. The width of the BLMMb is the difference between the total molar width of the mesial plane (M.1) to the width of the BBMMb, while the BLMMb is the result of the reduction of BBDMMb to the distal plane of the M.2 mandibular molar. The same measurements were also made on the maxillary molars. The width of all planes was measured directly except the width of the palatal plane on each molar. Like BLMMMb, the mesial palatal plane of the maxillary molars (BMPMMx) is the difference between the width of the mesial plane of the maxillary molars (BMMMx) and the buccal mesial plane of the maxillary molars (BBMMMx). The width of the maxillary molar distal palatal plane (BDPMMx) was obtained by subtracting the maxillary molar distal plane (BDMMx) by the molar distal plane and the maxillary buccal molar plane (BDBMMx).

Statistical analysis

The measurement data are recorded, tabulated, and presented in the form of mean and standard deviation. Size differences between molar width, molar notch, and molar plane were analyzed by two-way analysis of variance without interaction. The difference in width is significant if the test results have an error probability of less than five percent. If the test results are significant, it is tested with Duncan to see the difference in the pair at the five percent level. Test equipment using SPSS 20.

Results and Discussion

Individual influence on the width of the occlusal plane

The variables analyzed on mandibular molars were seven variables that showed a very significant individual effect ($p < 0.01$). These variables include M.1Mb, M.M.Mb, M.2Mb, BBMMb, BBDMb, and BLMMb except that BLDMb showed no significant effect ($p > 0.05$). In contrast to the width of the maxillary molars, six variables showed a significant individual influence on the width of the occlusal plane of the molars. These variables include M.M.Mx, M.2Mx, BBMMx, BB DMx, while the variables are M.1Mx, BPMMx, and BPDMx ($p > 0.05$) (Table 1 and Figure 1).

Total Width of Mandibular Molar Occlusal Plane

The width of MMb11 was significantly shorter than MMb21 or MMb31 ($p < 0.06$). The MMb21 width was not significantly different from the MMb32 width ($p > 0.05$). The indentation plane width between MMb11MMb12 and MMb21MMb22 or MMb31MMb32 did not show a significant difference ($p > 0.05$). The indentation plane width of MMb21MMn22 against MMb31MMb32 also did not show a significant difference ($p > 0.05$). The complete mandibular molar width data is presented in Table 2.

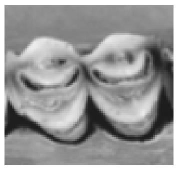


Fig. 1. The Measured Plane (Halstead and Collin, 2002).

Table 1. Individual influence on the width of the occlusal plane

Molar parts	Significance	
	Mandibula	Maxilla
M.1M	0.002**	0.086 ^{ns}
M.M.M	0.009**	0.003**
M.2M	0.025*	0.000**
BBMM	0.007**	0.006**
BBDM	0.000**	0.000**
BML/PM	0.008**	0.502 ^{ns}
BDL/PD	0.529^{ns}	0.543 ^{ns}

Superscript * significantly different between individuals ($p < 0,05$), ** very significantly different between individuals ($p <0.01$), ^{ns} between individuals is not significantly different ($p>0.05$)

Buccal series. The width of BBLMM1Mb was significantly narrower for both BBLMM2Mb and BBLMM3Mb ($p < 0.05$). BBLMM2Mb width was not significantly different from BBLMM3Mb ($p > 0.05$). BBLDM1Mb width was not significantly different from BBLDM2Mb ($p > 0.05$) but significantly narrower than BBLDM3Mb width ($p < 0.05$). BBLDM2Mb width was not significantly different from BBLDM3Mb ($p < 0.05$).

Lingual Series. BBMM1Mb width is not significantly different from both BBMM2MB and BMM3Mb width ($p > 0.05$). BBDM1Mb width is not significantly wider than BBDM2Mb width ($p > 0.05$), but significantly wider than BBDM3Mb width ($p < 0.05$). BBDM2Mb width is significantly wider than BBDM3Mb width ($p < 0.05$).

Total Width of Maxilla Molar Occlusal Plane

The M11Mx width did not differ significantly from the M21Mx width or the M31Mx width ($p > 0.05$), as well as between M11Mx and M21Mx did not show a significant width difference ($p > 0.05$). The width

Table 2. Total Width of Mandibular Molar Occlusal Plane of CE Goat

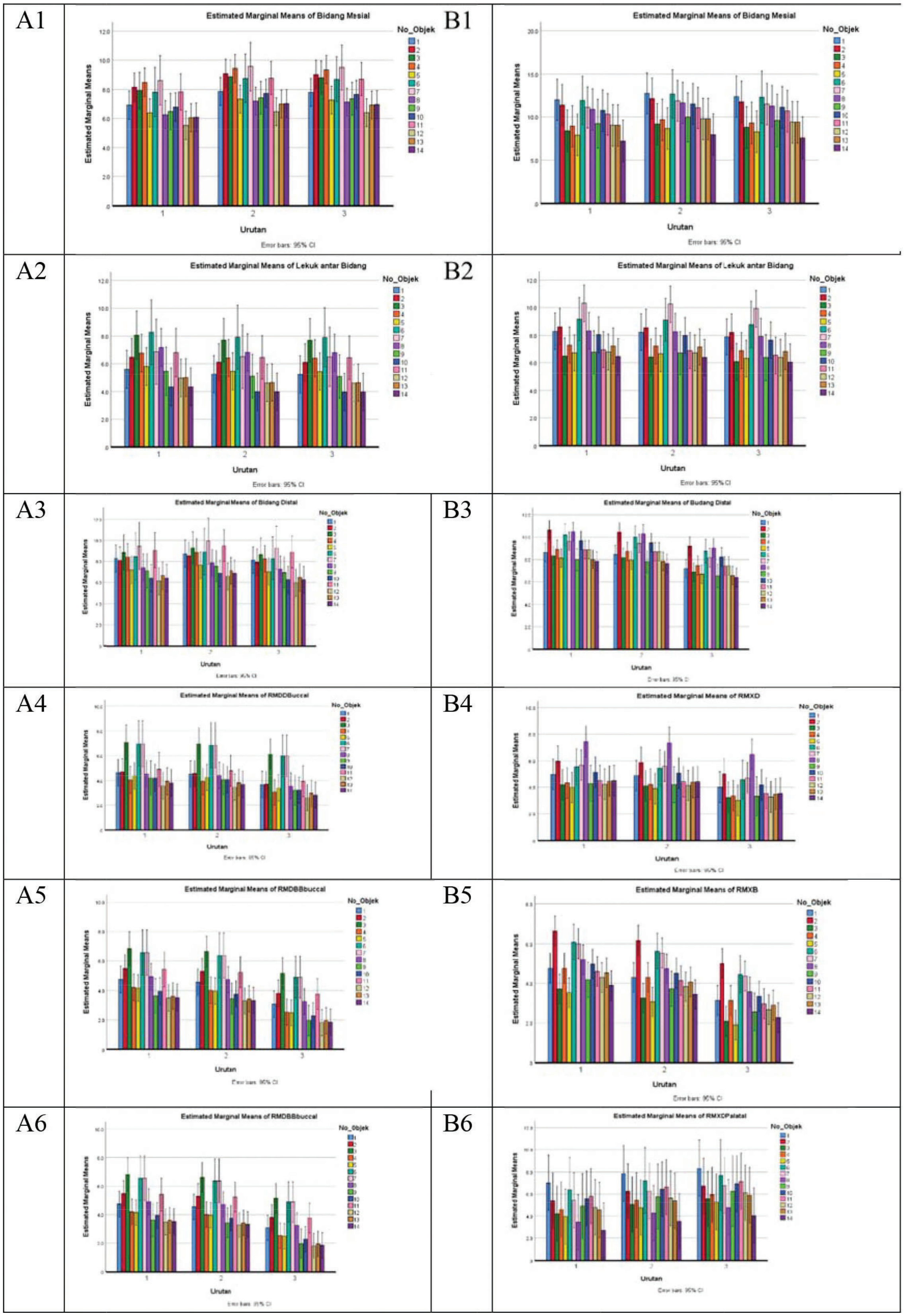
Teeth	$\overline{X}$ ± sd (mm)		
	1	Indentation plane width	2
M1Mb	7.04 ± 0.90 ^{a}	5.93 ± 1.04	7.59 ± 1.15
M2Mb	7.94 ± 0.95 ^{b}	5.80 ± 1.18	8.11 ± 1.02
M3Mb	7.98 ± 1.42 ^{b}	5.77 ± 1.83	7.56 ± 1.60

Different superscripts in the same column are significantly different ($p<0.05$).

Table 3. Width of Mandibular Molar Occlusal Plane of CE Goat

Teeth	Buccal Series		Lingual Series	
	Mesial Plane $\overline{X}$ ± sd (mm)	Distal Plane $\overline{X}$ ± sd (mm)	Mesial Plane $\overline{X}$ ± sd (mm)	Distal Plane $\overline{X}$ ± sd (mm)
M1Mb	4.19 ± 0.72	4.23 ± 0.51^{a}	2.57 ± 0.82 ^{a}	3.01 ± 0.23 ^{a}
M2Mb	4.37 ± 0.77	4.31 ± 1.24 ^{a}	3.48 ± 0.88 ^{b}	3.65 ± 1.13 ^{ab}
M3Mb	3.87 ± 1.56	3.13 ± 1.36 ^{b}	4.11 ± 1.38 ^{b}	4.43 ± 0.97 ^{b}

Different superscripts in the same column are significantly different ($p<0.05$).


A1
Estimated Marginal Means of Bidang Mesial
B1
Estimated Marginal Means of Bidang Mesial
A2
Estimated Marginal Means of Lekuk antar Bidang
B2
Estimated Marginal Means of Lekuk antar Bidang
A3
Estimated Marginal Means of Bidang Distal
B3
Estimated Marginal Means of Budang Distal
A4
Estimated Marginal Means of RMDDBuccal
B4
Estimated Marginal Means of RMXD
A5
Estimated Marginal Means of RMDBBbuccal
B5
Estimated Marginal Means of RMXB
A6
Estimated Marginal Means of RMDBBbuccal
B6
Estimated Marginal Means of RMXDPalatal
No_Objek
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Error bars: 95% CI

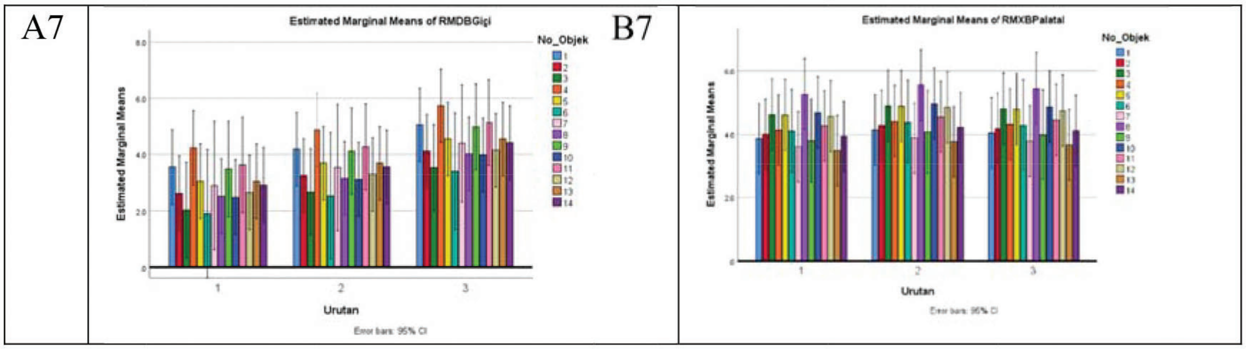

Fig. 1. A. Occlusal plane of molar mandibulae. B. First occlusal plane of molar maxillae.1.M.1M. 2. M.M.M. 3. M.2M. 4. BBMM. 5. BBDM.6. BML/PM. 7. BDL.PD planes. The multicolored bar chart shows the number of mandibular or maxillary samples of Etawa crossbreeds analyzed. Figures 1, 2, and 3 of the abscissa field represent the order of the molars in both the mandible and maxilla. The protrusion of the confidence interval across the abscissa in a downward direction as shown in Figure B is due to the mandibular sample containing some of the molars that have not yet emerged.

of the curve between the planes (M11, M12Mx, M21, M22Mx, and M31, M32Mx) did not show a significant difference in width ($p > 0.05$) (Table 4). A significant difference in width was seen in the ratio of the widths of the distal maxillary molars. The M12Mx width is not significantly different from the M22Mx width ($p > 0.05$). The M32Mx width is significantly narrower than the M12M or M22Mx width ($p < 0.05$).

Buccal Width. BBM1Mx width was not significantly different from BBMM2Mx width ($p > 0.05$) but significantly wider than BBMM3Mx width ($p < 0.05$). BBM2Mx width also shows wider than BBMM3Mx ($p < 0.05$).

Palatal Width. The width of the mesial plane of the palatal series between the three molars did not show a significant difference in width ($p > 0.05$). The same thing is also seen in BPDM1Mx, BPDM2Mx and BPDM3Mx, between the three there is no significant difference ($p > 0.05$) (Table 5).

Data analysis in this study showed that most of the occlusal planes of the CE goat molars were determined by the individual, location, the order in location, and the occlusal planes in the molars except for the total width of the mesial plane of the maxillary molars, the distal plane of the lingual series of the mandibular molars, the mesial plane of the buccal series and palatal series of maxillary mo-

Table 4. Total Width of the Maxillary Molar Occlusal Plane of CE Goat

Teeth	$\overline{X} \pm$ sd (mm)		
	1	Indentation plane width	2
M1Mx	9.87 ± 2.06	7.68 ± 1.40	9.02 ± 0.96 [a]
M2Mx	10.62 ± 1.37	7.61 ± 1.03	8.84 ± 1.06 [a]
M3Mx	10.12 ± 2.85	7.22 ± 1.79	7.56 ± 1.21 [b]

Different superscripts in the same column are significantly different (p<0.05).

Table 5. Width of each section of the maxillary molars occlusal plane of the CE goat

Teeth	Buccal Series		Palatal Series	
	Mesial Plane $\overline{X} \pm$ sd (mm)	Distal Plane $\overline{X} \pm$ sd (mm)	Mesial Plane $\overline{X} \pm$ sd (mm)	Distal Plane $\overline{X} \pm$ sd (mm)
M1Mx	4.95 ± 1.58 [a]	4.79 ± 0.96 [a]	4.92 ± 1.71	4.22 ± 0.90
M2Mx	4.86 ± 1.05 [b]	4.33 ± 1.18 [b]	5.76 ± 1.18	4.50 ± 0.84
M3Mx	3.99 ± 0.80 [b]	3.11 ± 0.90 [c]	6.11 ± 2.78	4.45 ± 0.84

Different superscripts in the same column are significantly different (p<0.05).

lars. If the individual is considered uniform, then the mandibular first molar is characterized by a total mesial plane width or a narrower mesial lingual plane than the other two mandibular molars. The mandibular third molars are characterized by the distal plane of the buccal series being smaller than the other two molars. The mandibular second molars have characteristics located in between, the width of the distal buccal series which is not different from that of the mandibular first molars in the same plane and row, and the mesial plane of the lingual series which is not different from that of the third molars in the same row. The maxillary molars were distinguished by observing the distal plane of the buccal series. The width of the distal plane of the buccal series, successively, the first molar has the widest plane and then gradually decreases in the second and third molars. Another feature that distinguishes the first molar from the other molars is the wider mesial plane of the buccal series (Kierdorf *et al.,* 2012).

In general, the width of M1 which is shorter than M2 or M3 is equal to the size of the molar tooth row similar to the discovery in Soay sheep (Witzel *et al.,* 2018). The teeth shape is influenced by genetics and the environment, especially food. Ruminant molars have the main function of breaking down food through the process of chewing food along with the maxillary molars. The impact of the work of the molars causes abrasion which appears as wear of the occlusal plane and a decrease in the height of the molars, making them appear wider. The finding that the width of the premaxillary teeth is narrower than the molars widens the chewing area (occlusion) increases with workload (Mendoza *et al.,* 2002). In addition, the action impact of the molars causes erosion that appears as wear of the occlusal plane. In this study, five of the fourteen molars examined showed wear on the M1 (data not shown). M32 gap is narrower than M22 or M12 due to the later growth of M3 teeth than M1 or M2 (Winder and Kaiser, 2015). This has an impact on the uneven pressure on the occlusal plane, in which is the pressure on the M3 occlusal plane is smaller than M2 or M3. This results in less wear on the occlusal plane than the occlusal plane of the two front molars. In this study, it was found that two of the fourteen molars examined had M3 which was shorter in height than the two molars in front of it (data not shown). There was no difference in the indentation width between the molars, indicating that the difference in the width of the molars was local. Geigel *et al.* (2018) divide tooth erosion into three stages. In the first stage, the crypts are visible even though at this time there is no alveolar erosion. In the second stage, the alveolar ridge begins to erode but has not yet reached the occlusal plane. The third stage of erosion has reached the occlusal plane. This last stage is called the complete erosion stage. In this study, five of the fourteen molars examined, M1 showed no crypts. It is highly suspected that the M1 has undergone erosion at the perfect stage. The finding of complete erosion and narrower crypt width in M32 led to the suggestion that erosion occurred from M1 to M3.

Conflict of Interest

Authors declare that they have no conflict of interest.

Acknowledgments

The authors express sincere thanks to the Ministry of Research, Technology and Higher Education of the Republic of Indonesia for funding research and Dean Faculty of Veterinary Medicine for providing all necessary facilities and fund for conducting research work.

Authors' Contribution

S designed the study, interpreted the data, and drafted the manuscript. HE, Wand VFH were involved in collection data and also contributed in manuscript preparation. S, WW and EMLtook part in preparing and critical checking of this manuscript.

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