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RESEARCH ARTICLE

Phenotypic characteristics of gaolao strain of Nagpuri buffalo breed

S.G. GUBBAWAR, **R.R. SHELKE**, S.D. CHAVAN AND S.R. POHARE

Author for Correspondence -
R.R. SHELKE
Department of Animal Husbandry and Dairying, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA
See end of the article for **Coopted authors'**

ABSTRACT - The findings emerged out of the present study are confined to establish the physical characteristics of gaolao strain of Nagpuri buffalo breed. The main object of the study was to identify the different phenotypic characters of gaolao strain of Nagpur buffalo breed located in Wardha district. The observations of the present study clearly established that the studied population of gaolao strain of Nagpuri buffalo breed was homogeneous and possessed certain physical characters distinctly which could form the base for identification.

KEY WORDS - Nagpuri buffalo, Gaolao strain, Phynotypic characters

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INTRODUCTION.....

Indian dairy industry seems to be buffalo oriented as buffaloes contribute to more than the 55 per cent of the total milk produced. It is observed that the choice of dairymen as well as individual milk producer in urban and rural area is buffalo, on account of its high butter fat content in milk and ability of animal to withstand adverse management conditions. In reference to this situation, more than 50 per cent of the world's buffalo population is confined to India. Obviously, the best buffaloes are only habitat in the country. They are grouped in over a dozen important breeds in India, of which Marathwada, Pandharpuri and Nagpuri/ Berari belong to Maharashtra (Kaikini and Pargaonkar, 1969). The number of high yielding cattle and buffaloes is increasing and there is decline in the population of indigenous cattle. Nagpuri breed has its native area in Maharashtra. However, it is believed by the people that although the terms Nagpuri, Ellichpuri, gaolao, Shahi, Pandharpuri and Marathwadi are synonymous, but the population do indicate distinct differences in their body confirmation and physical characteristics, thereby forming different groups.

RESEARCH METHODS.....

The findings emerged out of the present study are confined to establish the physical characteristics of gaolao strain of Nagpuri buffalo breed. The main object of the study was to identify different phenotypic characters of gaolao strain of Nagpur buffalo breed located in Wardha district. The Wardha district is considered to be the home tract of gaolao strain and therefore each village of the district was possessing the buffalo population. However, Karanja, Ashti and Arvi Tahsils of the districts are known for dairy business and cattle markets wherein typical gaolao strain of Nagpuri buffalo breed were maintained. Considering these subjective criteria, villages in each Tahsil were selected. Information with regards to qualitative and quantitative morphological characters of 1000 buffaloes were collected from three Tahsils namely, Karanja, Ashti and Arvi of Wardha district. For this purpose the data on 350, 300 and 350 buffaloes from Karanja, Ashti and Arvi Tahsils, respectively were recorded to make the total sampling on 1000 buffaloes. For the collection of requisite information, performa prescribed by NBAGR was used. The collected information of 1000 gaolao strain of Nagpuri buffalo breed was belonging to different age groups as I (4-5 years), II (6-7

years), III (8-9 years) and IV (above 10years).

The variables like coat colour, shape and size of horn, head, eyes, ear, neck, body length, height at knee, neck, hip bone, tail length, length of switch, udder shape and size, teat length, hoof colour etc. were considered for identifying gaolao strain of Nagpuri buffalo.

Statistical analysis :

The data generated on quantitative measurements of characters were analyzed by employing Complete Randomized Design (CRD) with unequal number of observations in order to test the effect of age group on skeletal development as per the procedure given by Amble (1975).

RESEARCH FINDINGS AND ANALYSIS.....

The scientific review on buffalo breeds distinctly suggested that as like Murrah, Surti, Mehsana buffalo breeds, different strains of Nagpuri buffalo did not receive much attention from research point of view. Very limited information on breed characteristics are available though Nagpuri buffaloes have been recognized from ancient times. The typical characters noticed in the study are presented and discussed as below:

Morphological qualitative characters:

The qualitative characters have unique importance in identification of different breeds. One can identify the animals from long distance on the basis of these characters. With this view, the characters like body colour, ear and horn orientation and udder shape were studied. The observations recorded in Table 1 are discussed below.

It was noticed from Table 1 that gaolao strain of Nagpuri buffalo breed possessed distinctly different qualitative characters than that of other strains of Nagpuri buffalo breed. Majority of the typical gaolao buffaloes were possessing black coat colour (74%), prominent white colour patch on forehead (69%), prominent white patches on legs just above the hoof (86%) and white tail switch (64.20). However, the other colour pattern was also observed in buffaloes where in 12.00, 20.00, 6.00 and 3.30 per cent buffaloes had brown coat colour, brown patch on forehead, brown patches of on legs and brown tail switch, respectively while 14.00, 11.00, 8.00 and 32.50 per cent buffaloes exhibited black and white coat colour, no colour patch on forehead, legs and black tail switch, respectively. However, the differences between colour patterns were significant indicating the expression of other colour patterns could be by chance in gaolao strain of Nagpuri buffalo breed. The majority of buffalo population (72.40%) possessed black muzzle though substantial number of buffaloes (27.60%) indicated brown muzzle. However, the differences were significant. Moreover, there was dominance of white eye cornea colour in gaolao buffalo population, being present in 59.70 per cent buffaloes while 27.30 and 13.80 per cent buffalo showed black and brown eye cornea colour, respectively. This trend appeared to be in line with that of body coat colour. Thus, the observations on body colour revealed that the body colours reported by Patil and Ulmeck (2002) and Patil *et al.* (2006) for Pandharpuri buffaloes was black and brown, black with white patches and brown with white patches along with white switch of tail.

Moreover, Moon (1984), Chafle (1992), Bire *et al.* (1994) and Munnarwar (2000) reported brown coat colour with brown muzzle, white patch on fore head, without any colour patches on legs and white switch of tail for Purnathadi buffaloes of Nagpuri breed. Therefore, one could differentiate gaolao type buffaloes from that of Pandharpuri and Purnathadi buffaloes on the basis of body colours.

Orientation of ear and horn:

It is evident from Table 1 that long horizontal ears were common in gaolao type of buffaloes as 79.2 per cent buffaloes had shown this type of orientation, while dropping ears were present in 20.80 per cent buffaloes. Long horns is considered to be a typical character for Nagpuri buffaloes. The present results also confirmed this contention. Long sword like horns carried backward along the sides of the neck reaching upto shoulder observed in 75.80 per cent buffaloes while short sickle type shape were exhibited by 14.20 per cent buffaloes and short dropping horns were present in 10 per cent buffaloes. Hence, sword like orientation of horns could be a phenotypic marker of gaolao type buffaloes. However, this horn orientation is distinctly different from that of Murrah, Surti, Mehsana and Jafrabadi breeds of the country. Moreover Patil and Ulmeck (2002) reported that Pandharpuri buffaloes were having straight and curved horns which appears to be different from that of gaolao type horn orientation.

Udder shape:

The udder shape was observed in 1000 gaolao buffaloes which comprised the different age groups from 4 years onwards. It was noted that majority of gaolao buffaloes (53.40%) possessed bowl shaped udder and substantial number of buffaloes (38.60%) indicated round shaped udder. Moreover sizeable number of buffaloes (18.00%) exhibited goat type shaped udder. This means there would not be specific shape of udder in gaolao type buffaloes. However, statistical significance showed that bowl shaped udder as an typical character for gaolao type buffaloes. Radekar *et al.* (2003) observed that shape of udder in Pandharpuri buffaloes were prominently tough shaped, though in sizeable number of animals, it was bowl or round shaped. These observations, do not agree with the present trend where gaolao buffaloes possessed prominently bowl shaped udder. Hence, it could be considered a typical character of the strain.

Morphological quantitative character:

A definite relationship between the body size and confirmation of breed character have been established by the past research workers like Mangulkar and Desai (1978), Basu and Ghai (1982), Singh *et al*. (1995), Singh and Chowdhary, (1976). Therefore morphological measurement of buffaloes would unable to distinguish gaolao type buffaloes from other strains of Nagpuri breed and other buffalo breeds. In view of this, quantitative physical characters, in terms of measurement of different important body parts were recorded to describe the biometry of gaolao strain of Nagpuri buffalo breed. The results obtained in this regard are presented below:

Head region:

The measurements in respect of head length, head width, ear length, ear breadth, horn length, horn circumference at base and distance between two horns were included in this region. The observations recorded according to age groups are presented in Table 2 and discussed in following paragraphs.

Table 1: Morphological qualitative characterization in gaolao strain of Nagpuri buffalo breed (n = 1000)

Sr. No.	Characters	No. of observations	Percentage	χ^2 values	Significance
	Body colour				
1.	Coat colour				
	Black	740	74.00		
	Brown	120	12.00	744.00**	Sig.
	Black and white	140	14.00		
2.	Colour patches on forehead				
	White	690	69.00		
	Brown	200	20.00	584.00**	Sig.
	No patch	110	11.00		
3.	Patch on legs				
	White	860	86.00		
	Brown	60	6.00	1248.00**	Sig.
	No patch	80	8.00		
	Tail switch				
	White	642	64.20		
	Black	325	32.50	556.00**	Sig.
	Brown	33	3.30		
4.	Muzzle colour				
	Black	724	72.40		
	Brown	276	27.60	201.00**	Sig.
5.	Eye cornea colour				
	White	597	59.70		
	Black	273	27.30	343.00**	Sig.
	Brown	130	13.00		
Ear orientation					
1.	Long horizontal	792	79.20		
2.	Dropping	208	20.80	341.00**	Sig.
Horn orientation					
1.	Long sword like	758	75.80		
2.	Sickle backward shape	142	14.20	814.00**	Sig.
3.	Short dropping	100	10.00		
Udder shape					
1.	Bowl	534	53.40		
2.	Round	386	38.60	200.00**	Sig.
3.	Goat type	180	18.00		

** indicates significance of value at P=0.01

Head length:

It is observed from pooled means of Table 2 that the gaolao strain of Nagpuri buffalo breed had long head or face i.e. distance from pole to upper edge of muzzle. The average pooled head length in gaolao buffaloes was 56.64 cm. The measurement reported by Tayade (2006) in gaolao strain (55.03±8.60 cm) of Nagpuri breed is supportive to present value. Similarly, the head lengths observed by Chafle (1992), Shrikhande *et al.* (1996) in Nagpuri strain (52.29 to 51.51 cm) in gaolao buffaloes.

Head width:

On an average the head width in gaolao strain of Nagpuri buffalo was 26.95 cm. This head width appears to be higher than that reported by Ali *et al.* (1994) for Ellichpuri strain (20.97 cm), Bire *et al.* (1994) for Purnathadi strain (20.80 cm) and Singh *et al.* (1995[b]) for Mehasana (21.8 cm) and Tayade (2006) for gaolao strain (21.52 cm). Thus, the results clearly indicated that gaolao strain of Nagpuri buffalo had possessed broad head.

Ear length:

The overall ear length of gaolao strain of Nagpuri breed was 31.21 cm, indicating very long ears. The ear length reported by Patil and Ulmek (2002) for Pandharpuri buffalo (23.70 cm) and Tayade (2006) for gaolao buffalo (27.18 cm) appear lower than the present value. Moreover, the ear length reported by Dasburma *et al.* (2002) for Chilika buffalo (21.8 cm), Mahapatra *et al.* (2002) for Sambhalpuri buffalo (26.80 cm) and Patil and Ulmek (2002) for Pandharpuri (23.82 cm) are also comparatively less as compared to the present ear length of gaolao buffalo. Therefore, these observations do not agree with the present trend.

Ear breadth:

The overall ear breadth in gaolao bufafloes was 20.08 cm which appeared to be quite broad. It is already pointed out that, gaolao buffaloes had longer ear and thereby it is just possible to have more breadth of the ear. Tayade (2006) reported ear breadth of 12.82±0.136 cm in gaolao strain of Nagpuri breed which appears far lower than the present observations. Probably record of his observations on small number of buffaloes and in different locality of home tract might be the reasons for variation. Thus, the gaolao strain of Nagpuri buffaloes breed possessed long ear thereby proportionate border breadth of the ear.

Horn length:

The overall horn length in gaolao strain of Nagpuri buffalo breed was 75.22 cm indicating sufficiently long horn in buffaloes. The past literature and research work have focused on horn characters in buffalo, being long, flat and thick Kaikani and Pargaonkar (1969; Ranjan and Pathak, 1983). This contention is confirmed from the present results. Therefore long horn is one of the phenotypic characters for identification of gaolao buffaloes. Tayade (2006) reported a horn length of 75.68±1.85 cm in gaolao buffalo which is similar to the present value.

Horn circumference at base:

The pooled horn diameter at the base was 29.89 cm, indicating very thick horns as compared to other strains of Nagpuri buffalo breed. This logic is supported by the past research workers where Chafle (1992), Kolte and Sadekar (1996) and Tayade (2006) reported a diameter of 18.98+0.17, 16.30+1.21 cm and 17.87+0.97 cm, respectively in gaolao strain of Nagpuri buffalo breed. Therefore, long thick horns are typical characters of gaolao strain of Nagpuri buffalo breed.

Distance between two horns:

As a result, the pooled average of the distance between two horns in gaolao strain of Nagpuri breed was 18.16 cm (Table 2). This measurement confirmed the earlier contention that gaolao buffaloes had medium head crest. Chafle (1992), Kolte and Sadekar (1996) and Tayade (2006) reported the distance between two horns in gaolao buffalo as 20.60, 13.95

Table 2: Morphological quantitative characters of head region in gaolao strain of Nagpuri buffalo breed as influenced by age groups

Character	Group according to age								Pooled average
	I (4 to 5 years)		II (6 to 7 years)		III (8 to 9 years)		IV (10 and above)		
	Average	SE (m) ± (CV%)	Average	SE (m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	
Head length (cm)	55.69	0.163 (4.33)	56.15	0.126 (3.73)	57.66	0.120 (3.31)	57.38	0.142 (4.08)	56.64
Head width (CM)	26.83	0.120 (6.88)	26.01	0.105 (6.82)	27.82	0.122 (6.93)	28.14	0.150 (8.49)	26.95
Ear length (cm)	30.10	0.125 (6.19)	31.11	0.070 (5.67)	31.12	0.119 (6.08)	32.52	0.117 (5.72)	31.21
Ear breath (cm)	18.70	0.089 (7.10)	20.08	0.070 (5.67)	20.77	0.085 (6.70)	20.77	0.075 (5.84)	20.08
Horn length (cm)	65.03	0.730 (6.48)	74.95	0.235 (5.28)	78.84	0.137 (2.75)	80.36	0.143 (2.90)	75.22
Horn circumfarance (cm)	29.60	0.113 (5.67)	28.64	0.11 (6.45)	30.01	0.08 (4.25)	31.46	0.028 (2.33)	29.89
Dist. between two horns (cm)	16.69	0.075 (6.68)	17.94	0.122 (2.50)	18.36	0.017 (1.48)	19.48	0.028 (2.33)	18.16

(Means with similar superscript and column do not differ significantly)

and 17.17 cm, respectively.

Neck region:

Development of neck region always emphasized from drought quality point of view. Many earlier research workers opined that Nagpuri buffalo breed possessed milk and draft qualities comparatively more than any other buffalo breed of the country and therefore, males were used for heavy draft purpose in rural area of home tract Kaura (1961 and ICAR 1979a). In view of this, the observations on neck length and girth (circumference) were recorded and presented in Table 3.

Neck length:

It is further observed from Table 3 that the pooled average of neck length in gaolao strain of Nagpuri buffalo breed was 64.82 cm confirming the earlier contention that the buffalo possessed long neck. The past workers like Raghavan (1960), Kaura (1961), Whyte and Mathur (1986), reported that Nagpuri buffalo had long neck. The present observations are in agreement with their opinion. Moreover, neck length noticed in gaolao strain of Nagpuri buffalo breed appeared two times more than the neck length observed in Murrah buffalo (31.91 cm) by Saini and Gill (1986). Thus, a longer neck could be observed in older buffaloes as compared to younger age animals. Secondly, long neck crest could be the sign of good draft quality as draft animals are selected on the basis of neck crest development.

Neck girth (circumference):

It is evident from Table 3 that on an average neck girth in gaolao buffaloes was 82.85 cm, indicating sufficiently thick neck. However, the neck circumference (104.53+1.50 cm) reported by Tayade (2006) in gaolao buffaloes appears higher than the present value. Moreover, the neck circumference reported by Patro and Mishra (1986) for Parlakimedi buffalo (98.62+3.27 cm) and Saini and Gill (1986) for Murrah buffalo (96.37 cm) seems to be moderately higher than the present neck circumference values of gaolao buffaloes.

Body region:

This region comprised the measurements on body length, height at wither point, chest and belly girth. These measurements are useful in order to know the overall development of the animal and general built up. In reference to this, various body region measurements were recorded as presented in Table 4 and discussed below:

Body length:

The overall body length in gaolao buffalo was 135 cm indicating medium body size. Raghavan (1960), Kaura (1961) and Kaikani and Pargaonkar (1969) mentioned that Nagpuri buffalo was lighter in built than other buffalo breeds. These observations do support the present trend. Therefore, longer body in gaolao strain in relation to other strain of Nagpuri buffalo breed could form the phenotypic characters for differentiation.

Chest girth:

The overall chest girth of buffalo was with an average value of 179 cm. The chest girth values reported by Chafle (1992) and Kolte and Sadekar (1996) for gaolao buffalo as 177.47 and 173.00 cm, respectively are nearer with that of present values, while the observation of Tayade (2006) on chest girth of gaolao buffalo (186.89 cm) does appear marginally more by 7.0 cm over the present value.

Barrel girth:

The pooled average barrel girth in gaolao buffalo was ranging from 212.50 to 237.00 cm with average value of 222.45 cm after 4 year of age. The barrel girth reported by Mangrulkar and Desai (1978) for Nili grade (208.43 cm), Dhamma *et al*. (1984) for UP buffalo (210.50 cm), Patil and Ulmek (2002) for Pandharpuri (202.67 cm), Goel *et al*. (2003) for Bhadawari buffalo (199.48 cm), Singh *et al.* (2003) for Bhadawari (204.52 cm) and Warade (2004) for Surti buffalo (207.12 cm) are lower than present barrel girth of gaolao buffaloes. Thus, the gaolao strain of Nagpuri buffalo breed possessed medium barrel and development of barrel could not form the basis for differentiating the gaolao buffalo from the buffaloes of other breed.

Distance between hip to pin bone:

It is seen from Table 4, that the distance from hip to pin bone in gaolao buffalo was ranging from 37.00 to 56.50 cm with an average value of 47.54 cm. The distance reported by Ali *et al*. (1994) for Ellichpuri strain (38.71 cm) and Bire *et al*. (1994) for Purnathadi strain (42.30 cm) appears less than the distance observed in the present study of gaolao strain.

Table 3: Morphological quantitative characters of neck region in gaolao strain of Nagpuri buffalo breed as influenced by age groups

Character	Group according to age								Pooled average
	I(4 to 5 years)		II (6 to 7 years)		III (8 to 9 years)		IV(10 and above)		
	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	
Neck length (cm)	56.06	0.309 (8.17)	67022	0.122 (2.50)	67.23	0.133 2.93)	68.78	0.158 (3.63)	64.82
Neck circumfe-rence (cm)	81.92	0.276 (4.92)	81.94	0.122 (2.50)	83.28	0.187 (3.56)	84.64	0.146 (2.76)	82.85

Means with similar superscript and column do not differ significantly

Table 4: Morphological quantitative characters of body region in gaolao strain of Nagpuri buffalo breed as influenced by age groups

Character	Group according to age								Pooled average
	I (4 to 5 Years)		II (6 to 7 Years)		III (8 to 9 Years)		IV (10 and above)		
	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	
Body length (cm)	134.00	0.524(5.80)	134.04	0.156(1.88)	135.02	0.168(1.96)	136.94	0.542(6.28)	135.00
Chest girth	172.38	0.209(1.65)	179.25	0.207(1.82)	180.17	0.18(1.55)	183.41	0.125(1.04)	179.00
Barrel girth (cm)	222.20	0.155(1.03)	222.23	0.212(1.55)	222.67	0.145(1.02)	222.70	0.131(0.94)	222.45
Dist. Bet. Hip bone and pin bone (cm)	41.27	0.144(5.19)	46.34	0.138(5.019)	51.26	0.197(6.01)	51.27	0.238(7.31)	47.54
Dist. Bet. Pin bone to hock joint (cm)	74.60	0.146(2.92)	75.45	0.142(3.17)	71.59	0.160(3.54)	72.64	0.426(5.65)	73.60

(Means with similar superscript and column do not differ significantly)

Distance from pin bone to hock joint:

On perusal of Table 4, revealed that the overall distance from pin bone to hock joint was ranging from 61.25 to 80.25 cm with average value of 73.60 cm. However, the length of pin bone to hock joint showed significant differences between the age groups. But a definite trend was not noticed.

Height of buffalo:

The height of animal was measured at various points of body in order to know the overall skeleton development of the animal as well as the judgment on the symmetry of the body. The data on height at wither point, front knee, back knee, hip bone and pin bone of the animal were included. The observations are presented in Table 5.

Body height at wither:

The overall body height of gaolao strain of Nagpuri buffalo breed was 116.60 cm, indicating a medium height buffalo. Moreover, the body height reported by Chafle (1992), Kolte and Sadekar (1996) and Tayade (2006) for gaolao buffaloes as 121.71, 124.19 and 127.43 cm, respectively is also on higher side than that of present value.

Height at knee:

The pooled average of height at knee was 37.97 cm. This height at knee appears substantially higher than that observed in other reputed buffalo breed. ICAR (1979) in their bulletin reported the average height of 20, 22 and 19 cm in Mehsana, Murrah and Surti buffalo, respectively. This means the length of shank bone along with hoop were more in gaolao strain of Nagpuri buffalo breed. Strong forelimbs are necessary for draft ability and gaolao buffaloes are used for draft purpose in their home tract. Thus, the long front knee could be considered as important phenotypic character in gaolao strain of Nagpuri buffalo breed.

Height at hock:

The pooled average height at back knee was ranging from 39.50 to 73.25 cm in gaolao buffaloes with an average value of 52.86 cm. The hock height observed by Singh *et al.* (1995a) for Mehsana buffalo (47.90 cm) appears lower than present value. This means gaolao buffaloes were tall in respect of hind portion against Mehsana breed.

Height at hip bone:

It was observed that the overall height at hip bone in gaolao strain of Nagpuri buffalo breed was ranging from 123.25 to 137.25 cm with average height of 128.94 cm. The comparison of this height at hip bone with that of other buffalo breeds reported by ICAR (1979) revealed that gaolao buffaloes are

Table 5: Morphological quantitative characters of height in gaolao strain of Nagpuri buffalo breed as influenced by age groups

Character	Group according to age (height in cm)								Pooled average
	I (4 to 5 Years)		II (6 to 7 Years)		III (8 to 9 Years)		IV (10 and above)		
	Average	SE (m)± (CV%)	Average	SE (m)± (CV%)	Average	SE (m)± (CV%)	Average	SE (m)± (CV%)	
Body height at wither	111.97	0.135 (1.79)	116.70	0.136 (1.95)	117.88	0.141 (1.90)	119.85	0.104 (1.38)	116.60
Average height at knee	37.11	0.114(4.32)	37.83	0.118 (5.26)	38.02	0.114 (4.76)	38.93	0.140 (5.69)	37.97
Height at hock	48.00	0.154(4.76)	49.17	0.177 (6.05)	56.64	0.228 (6.02)	57.61	0.253 (6.03)	52.86
Height at hip bone	126.67	0.222(2.55)	130.21	0.115 (1.46)	129.28	0.176 (2.14)	129.61	0.467 (5.67)	128.94
Height at pin bone	118.81	0.137(1.70)	120.27	0.117 (1.63)	120.62	0.136 (1.76)	119.65	0.426 (5.65)	119.88

(Means with similar superscript and column do not differ significantly)

Table 6: Morphological quantitative characters of hind limbs in Gaolao strain of Nagpuri buffalo breed as influenced by age groups

Character	Group according to age								Pooled average
	I (4 to 5 Years)		II (6 to 7 Years)		III (8 to 9 Years)		IV (10 and above)		
	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	
Tail length (cm)	81.23	0.228 (4.15)	86.52	0.235 (4.32)	90.78	0.466 (8.06)	90.82	0.330 (5.32)	87.34
Switch length from tip to tail (cm)	31.69	0.107 (5.17)	33.65	0.115 (5.71)	36.62	0.126 (5.48)	34.48	0.288 (13.1)	34.11

(Means with similar superscript and Column do not differ significantly)

taller in hind portion than Mehsana (122 cm) and Surti (125 cm) while shorter against Murrah (130 cm) buffalo breeds.

Height at pin bone:

The pooled average height at pin bone in buffaloes ranged between 114.50 to 127.25 cm with an average value of 119.88 cm. The present observation seems higher than that of reported value by ICAR (1979) for Mehsana (112 cm) and Surti (113 cm) buffalo breeds. While it is in close agreement with Murrah buffalo (119 cm). This means the hind region in gaolao buffaloes would be marginally more by 6 to 7 cm than Mehsana and Surti buffalo breeds. However, this character is not documented in literature for other strains of Nagpuri breed hence comparison is not possible.

Hind limbs:

The measurement in respect of tail length and length of switch from tip of tail were included in hind limb region. The tail character seems important from identification point of view between the breeds. The observations are recorded in Table 6 and discussed below:

Tail length:

Table 6 revealed that the overall tail length in gaolao buffalo was ranging from 78.75 to 101.50 cm with an average value of 87.34 cm. The tail length reported by Patil and Ulmek (2002) for Pandharpuri (85.21 cm) and Tayade (2006) for gaolao (84.51 cm) buffaloes of Nagpuri breed (upshots) are supportive to the present observation.

Switch length from tip of tail:

The average switch length was 34.11 cm, indicating that the buffaloes were possessing long switch of tail. Thus, the length of switch tail may not form reliable phenotypic character to indicate differences between buffalo strains or breed.

Udder size:

The udder size of gaolao buffalo was studied in terms of udder length, width and teat length in order to ascertained the productive capacity. The observations are presented in table 7 and discussed as below:

Udder length:

Irrespective of age, the udder length was ranging from 45.00 to 82.50 cm in gaolao buffaloes with an average length of 55.05 cm. The length reported by Khire *et al*. (1975) for Nagpuri buffalo (52.40 cm) and Maldhure (1989) for Berari buffalo (51.12 cm) are nearer and supportive to present value. Thus, the udder of gaolao strain of Nagpuri buffalo breed could be considered as medium length.

Udder width:

It is evident from Table 7, that the overall average udder width in gaolao buffalo was 39.75 cm with a range from 29.75 to 58.00 cm. This means the udder was small in size on the basis of width. However, the width reported by Khire *et al*. (1975) in Nagpuri buffaloes (33.90 cm) appears marginally less than the present value.

Teat length:

A perusal of Table 7, reveals that on an average the teat length irrespective of age group was varying from 10.00 to 20.00 cm with average value of 16.87cm. The trend therefore indicates that gaolao buffaloes possessed long teats

Table 7: Morphological quantitative characters of udder size in gaolao strain of Nagpuri buffalo breed as influenced by age groups

Character	Group according to age								Pooled average
	I (4 to 5 Years)		II (6 to 7 Years)		III (8 to 9 Years)		IV (10 and above)		
	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	Average	SE(m)± (CV%)	
Udder length (cm)	47.84	0.327 (10.15)	52.69	0.139 (4.45)	59.04	0.422 (9.53)	60.63	0.304 (6.33)	55.05
Udder width (cm)	36.75	0.287 (11.59)	39.23	0.090 (9.68)	41.53	0.187 (6.09)	41.50	0.230 (6.96)	39.75
Teat length (cm)	12.90	0.156 (7.97)	17.45	0.083 (18.00)	18.14	0.078 (6.84)	18.99	0.085 (7.11)	16.87

(Means with similar superscript and column do not differ significantly)

Table 8: Average body weight (kg) in gaolao strain of Nagpuri buffalo breed as influenced by age groups

Group	Year	N	Min.	Max.	Average	SE(m)±	CV %
I	4-5	220	325	431	375.74	2.203	8.69
II	6-7	282	375	450	419.80	1.077	4.31
III	8-9	250	325	425	412.92	0.989	3.78
IV	10 and above	248	375	492	433.94	0.728	2.64
Pooled average			350.00	449.50	411.89		

Mahapatra *et al*. (2002) also noticed long teat in Sambhalpuri buffaloes which supports the present trend. Thus on the basis of udder measurements, it can be said that, gaolao strain of Nagpuri buffalo breed had udder medium and compact with long teat as compared to other well defined buffalo breeds.

Body weight of buffaloes:

Body weight is most commonly used, character for expression of body size in buffaloes. Secondly, the feeding requirement of the animals are dependent on their body weight. Obviously the economics of feeding is related with this character. Considering this aspect, the body weights of gaolao buffaloes were calculated by formula method where body length and chest girth measurements were considered. The average body weight in gaolao strain of Nagpuri buffalo breed as influenced by age groups are shown in Table 8.

It was observed that irrespective of age groups, the body weights in buffaloes were ranging from 350.00 to 449.50 kg with overall average weight of 411.89 kg (Table 8). Thus, on the basis of body weights, it can be said that gaolao strain of Nagpuri buffalo breed was lighter to medium sized buffalo. This logic is supported by the observations of Saini *et al*. (1989) where they mentioned that medium sized buffalo had a body weight of 475.55 kg and these animals were more economical than those weight on lower or higher side. Moreover, majority of the earlier research workers also opined that, Nagpuri breed buffaloes were lighter in built (Raghavan, 1960; Kaura, 1961; Kaikani and Pargaonkar, 1969). These observations supports the present trend on body size of the buffalo. Thus, it can be said that the body weight of gaolao strain of Nagpuri buffalo breed would be closer to Nagpuri and Ellichpuri strains and Pandharpuri buffalo but would be lower than that of Purnathadi strain of Nagpuri buffalo breed and other breeds of the country like Murrah, Mehsana and Bhadawari.

Conclusion:

The observations of the present study clearly established that the studied population of gaolao strain of Nagpuri buffalo breed was homogeneous and possessed certain physical characters distinctly which could form the base for identification. The significant characters of gaolao strain could be as below:

- Black coat colour with prominent white patches on forehead and legs just above the hoofs along with white switch of tail were the prominent and common colour pattern in buffaloes. Any deviation could be the point of disqualification.
- Long and remarkably thick horn at base placed at medium distance with sword like orientation upto shoulder were the typical characters of identification. This character was supported by long wider head and long wider breadth ears in gaolao buffaloes.
- The gaolao strain of Nagpuri buffalo breed possessed longer body against the other strains with medium height and short tail reaching to hock joint.
- The buffaloes were medium sized animals having 411.89 kg BW and possessed 56.64, 26.95, 21.31, 75.22, 29.89, 135.00, 116.50 and 87.34 head length, head width, ear length, horn length, horn circumference at base, body length, height at wither and tail length respectively.
- Horn length, tail length, body length, chest girth could be considered as phenotypic marker on the basis of correlation regression contribution in skeletal development in terms of BW and be used for differentiation of gaolao strain from other strains of Nagpuri buffalo breed.
- The buffalo had medium length compact, bowl shaped udder with long teats.

COOPTED AUTHORS' –

S.G. GABBAWARR, S.D. CHAVAN AND S.R. POHARE, Department of Animal Husbandry and Dairying, Dr Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

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