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Research Article
Slaughter, Carcass and Non-Carcass Characteristics of Local Cattle and Buffalo in Indonesia

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Abstract

Background and Objective: Local cattle and buffalo slaughtered in public abattoirs vary widely in body fatness and live weight. The study was aimed to characterise carcass and non-carcass parameters of local cattle and buffalo differing in breed, sex and body fatness score using a carcass dressing procedure based on the national standard carcass definition. **Methodology:** A total of 291 cattle and buffalo were slaughtered at 20 public abattoirs from ten provinces of Indonesia. The slaughtered animals were classified according to breed (Bali, Madura, PO, local crossbred cattle, PFH and buffalo), body fatness score (very thin, thin, medium, fat and very fat) and sex (male and female). **Results:** The results indicated that the local cattle and buffalo slaughtered at public abattoirs were dominated by local crossbred cattle (59%), followed by Bali cattle (14%), PFH cattle (10%), PO cattle (8%), Madura cattle (7%) and swamp buffalo (2%). The animals were mainly in medium (49%) and poor (36%) conditions, while only 15% of the animals were in fat condition. Variations due to breed, age, sex and body fatness score were observed in slaughter weight, carcass and non-carcass characteristics. **Conclusion:** Overall, the majority of local cattle and buffalo of various breeds, ages and sexes slaughtered at public abattoirs in Indonesia had low to medium carcass productivity, which could be improved by increasing their body fatness score.

Key words: Local cattle, buffalo, abattoir, carcass, non-carcass characteristics

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Local cattle and, to some extent, buffalo are still the major source of domestic red meat production from ruminants. According to Ditjen PKH[1], there were approximately 14.8, 0.6 and 1.3 million heads of beef cattle, dairy cattle and buffalo, respectively. Of these animals, 2.3 million (13.7%) were slaughtered to supply approximately 70% of the domestic beef consumption. The local cattle breeds comprised 32.31% Bali cattle, 28.88% Ongole cattle, 8.67% Madura cattle and 30.14% local crossbreeds and other breeds[2]. The animals varied widely in term of frame size and, therefore, their performances[3,4].

Several studies have reported slaughter, carcass and non-carcass characteristics of local cattle and buffalo from several public abattoirs[5-8]. However, variation in the slaughtering techniques applied by public abattoirs might have become the major constraint in beef carcass studies due to their influence on carcass productivity[9]. There is a lack of information on slaughter, carcass and non-carcass productivity of local beef cattle and buffalo slaughtered at public abattoirs based on a standard carcass definition at a national level[10]. Slaughter and carcass data regarding local beef cattle and buffalo are important in estimating domestic beef supply and developing a strategy for local beef cattle improvement. This study was designed to investigate slaughter, carcass and non-carcass characteristics of local buffalo and cattle differing in breed, age, sex and body fatness score using a carcass dressing procedure based on the national standard carcass definition.

MATERIALS AND METHODS

Cattle and buffalo: The study involved 291 heads of local cattle and buffalo varying in breed, age, sex and body fatness score. The animals were obtained from 20 public abattoirs that were purposively selected from ten provinces in Indonesia, including North Sumatra (Medan and Karo abattoirs), Lampung (Metro city abattoir), DKI Jakarta (Cakung and Pulogadung abattoirs), Banten (Tangerang city and PT. Agrisatwa abattoirs), West Java (Bogor city, Bogor regency and PT. Elder Indonesia abattoirs), Central Java (Semarang and Salatiga abattoirs), East Java (Surabaya and PT. Surya Jaya abattoirs), West Nusa Tenggara (West Lombok and West Sumbawa abattoirs), South Kalimantan (Martapura and Banjarbaru abattoirs) and South Sulawesi (Makasar and Gowa abattoirs).

Procedures: Local cattle and buffalo were identified by breed, age by dentition and body fatness score. The identified animals comprised Bali, Madura, Peranakan Ongole (PO), Peranakan Fries Holland (PFH) and local crossbred cattle as well as swamp buffalo. Animal age identification was based on the presence and condition of permanent incisor teeth (I_0-I_4), while body fatness was determined by observation, palpation and scoring of body fatness score (BFS 1-5) according to McKiernan and Sundstrom[11].

Cattle slaughtering: The cattle were slaughtered according to halal procedure. Using the national standard carcass definition[10], the dressing procedure was carried out by the separation of head, feet, tail, skin, offal, reproductive organs and excessive fat to produce a carcass. The head removal was conducted between the *os. occipital* and the first *os. atlas*, the front feet were separated between the *carpus* and *metacarpus* and the hind feet were separated between the *tarsus* and *metatarsus*, while the tail was separated from the second *os. caudalis*. All carcass and non-carcass parts were weighed and recorded. The offal was divided into two categories, namely, red offal (heart, liver, trachea, lung, kidney, spleen) and green offal (*tractus digestivus*). The green offal comprised oesophagus, rumen, intestine and mesenterium and omentum fats.

Carcass adjustment: Several public abattoirs showed variations in carcass dressing that differed from the national standard of carcass dressing. Those differences were (a) Inclusion of the tail on the carcass, (b) Inclusion of the kidney in the carcass, (c) Inclusion of the tail and kidney in the carcass and (d) Separation of the tail from the *os. sacralis* and not from the *os. caudalis*. Those carcasses were, therefore, adjusted to a national standard carcass definition[10] to elucidate the differences in carcass dressing techniques.

Measurements: The observed parameters included slaughter weight, carcass weight and non-carcass weights including the head, feet, skin, tail, red offal (heart, liver, trachea, lung, kidney and spleen) and green offal (oesophagus, rumen, intestine and mesenterium and omentum fats). Slaughtered weight was the live weight of cattle prior to slaughter, while the green offal weight was the weight of the digestive tract after removal of the gut fill[12]. Total non-carcass weight was the sum of the weights of the non-carcass components. The carcass percentage was calculated as the hot carcass weight/slaughter weight × 100%, while the percentages of the non-carcass components were calculated from the weights of each\carcass component/slaughter weight × 100%. The total non-carcass percentage was calculated as the total non-carcass weight/slaughter weight × 100%.

Statistical analysis: The effects of breed, body fatness score and sex of cattle on slaughter, carcass and non-carcass characteristics were analysed by one-way analysis of variance and further differences between treatments were tested using Duncan's Multiple Range Test at a probability level of $p<0.05$[13].

RESULTS AND DISCUSSION

Variation in local cattle and buffalo slaughtered at public abattoirs: The local cattle and buffalo slaughtered at 20 public abattoirs varied widely in terms of breed, age by dentition, sex and body fatness score (Fig. 1). The local crossbreeds represented 59% of the total slaughtered cattle, followed by Bali (14%), FH (10%), Ongole Grade (8%) and Madura cattle (7%), while local buffalo represented only 2%. The high proportion of local crossbred cattle slaughtered at the public abattoirs, particularly in Java, indicated the preference of farmers to raise local crossbred cattle as beef producers relative to the other local cattle breeds. These crossbred cattle had a relatively high growth rate and gave better financial advantage to the farmers[14,15]. Grouping by sex of the animal, 73% of the slaughtered cattle and buffalo were male and 23% were female.

The age distribution of the slaughtered cattle and buffalo ranged from I_0-I_4 dentition. As shown in Fig. 1, 53% of the slaughtered animals were at the optimum age (I_1 and I_2 animals), while 18% of the local cattle and buffalo were slaughtered at a younger age (I_0) and 19% at an older age (I_4). The relatively high proportion of cattle and buffalo slaughtered at younger ages suggested that a limited number of animals were slaughtered at an optimum age. Harmini *et al.*[16] reported that sometimes farmers had to sell their cattle for cash to meet their immediate needs, such as school fees, health care, costs induced in early planting season and other urgent needs.

Based on a five-point body fatness scoring, 49% of the slaughtered cattle and buffalo were in medium body fatness condition (BFS 3), while 36% of those animals were in thin condition (BFS 2) and only 15% of the animals were in fat condition (BFS 4). Similar results have been reported by Prabowo *et al.*[17] and Sodiq and Budiono[18], who reported that slaughtered animals from local cattle raised by farmers predominantly had medium body fatness. This result suggests that a fattening programme for local cattle based on concentrate rations is not a common practice at the farmer level.

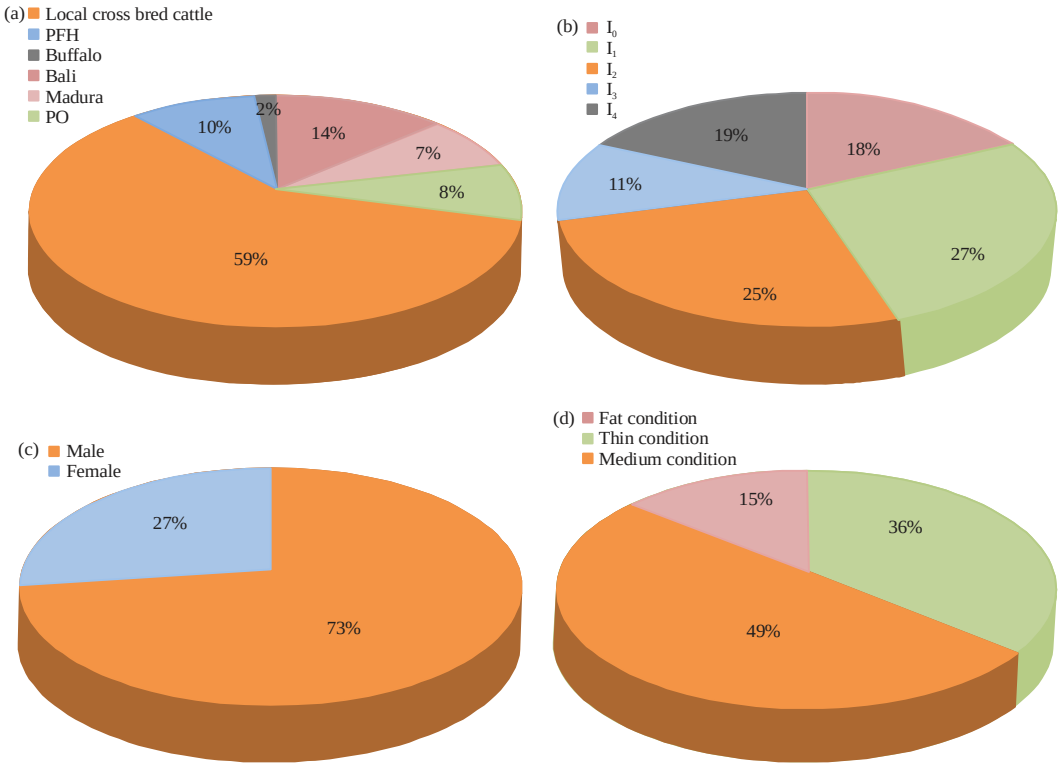

Fig. 1: Distribution of slaughtered cattle and buffalo based on (a) Breed, (b) Age by dentition, (c) Sex and (d) Body fatness score

Slaughter, carcass and non-carcass characteristics of local cattle and buffalo: Table 1 shows the overall slaughter and carcass weights as well as carcass and non-carcass percentages of local cattle and buffalo slaughtered at public abattoirs. The average slaughter weight of the large ruminants was 345.82 kg with a wide variation ranging from 155.00-630.00 kg, which produced carcass dressing percentage of 50.85% (41.54-60.65%) and an average non-carcass percentage of 25.77% (15.95-32.87%). Differences in the breed, feeding system, sex and age were believed to be the major cause of variation in the slaughter weight, carcass and non-carcass percentages[19-24].

Effect of breed: Breeds of local cattle and buffalo differed markedly in slaughter weight, carcass and non-carcass characteristics (Table 2). The slaughter weights ranked from the highest to the lowest were represented by PFH, local crossbred cattle, swamp buffalo, PO, Bali and Madura cattle. The slaughter weights of PFH and local crossbred cattle were significantly ($p<0.05$) higher than those of PO cattle and PO cattle were significantly ($p<0.05$) higher than those of Bali and Madura cattle. The slaughter weights of Bali, Madura, PO, PFH and local crossbred cattle were 276, 248, 318, 392 and 370 kg, respectively. Breed variation in slaughter weight was related to frame size differences[3,24]. Thus, the large-frame PFH and local crossbred cattle had heavier slaughter weights than the medium-frame PO and local buffalo and these medium-frame animals had heavier slaughter weight than the small-frame Bali and Madura cattle.

The slaughter weights of local cattle in this study, however, did not reach their optimal weight for the traditional market. It was reported that small-frame Bali and Madura cattle could reach their optimum weight at approximately 300 -350 kg[6,19,25]. Meanwhile, a medium-frame PO cattle might attain an optimum market weight range of 340-400 kg[20,26,24] and large-frame local crossbreeds (Simpo, Limpo) could reach market weight at 500-650 kg[24,27].

The trend in carcass yield from the local cattle breeds and buffalo was similar to that in slaughter weight. An increase in slaughter weight led to increased carcass weight as a result of increased amount and area of carcass tissues, including bone, muscle and fat[28-30]. Local crossbred cattle yielded the highest carcass weight and percentage. De Carvalho *et al.*[20] reported that local crossbred cattle could produce high beef yield, up to 81.8% of the carcass weight, indicating their potency as a meat-producing animal. Although, the carcass weights of PFH and local buffalo ranked the second and third heaviest, these breeds did not necessarily have high carcass dressing percentages. In fact, PFH and local buffalo had the lowest carcass percentages and the highest non-carcass percentages relative to the other breeds of beef cattle (Table 2). PFH is known as a dairy-type cow with less deposition of muscle in

Table 1: Means and ranges of slaughter, carcass and non-carcass characteristics of local cattle and buffalo in Indonesia

Parameters	Mean±SD	Minimum	Maximum
Slaughter weight (kg)	345.82±88.55	155.00	630.00
Carcass weight (kg)	176.42±48.32	72.47	334.89
Dressing percentage (%)	50.84±3.61	41.54	60.65
Non-carcass percentage (%)	25.77±2.72	15.95	32.87
Head	5.33±0.84	1.73	7.58
Wet skin	7.84±1.29	4.78	12.38
Feet	2.40±0.40	1.31	3.46
Tail	0.29±0.07	0.15	0.58
Red offal	3.85±1.40	1.43	8.83
Green offal	6.05±1.47	1.53	11.56

Table 2: Effect of breed of local cattle and buffalo on slaughter, carcass and non-carcass characteristics

	Breeds					
Parameters	Bali	Madura	PO	Local crossbreed	PFH	Buffalo
Slaughter weight (kg)	275.56±61.93^{cd}	248.05±70.99^{d}	317.75±81.39^{bc}	370.24±75.61^{a}	392.09±103.04^{a}	344.90±60.48^{ab}
Carcass weight (kg)	141.04±35.61^{bc}	128.90±45.16^{c}	164.47±49.04^{ab}	190.46±42.75^{a}	186.93±51.97^{a}	172.76±36.77^{a}
Dressing percentage (%)	50.95±3.49^{a}	51.07±4.50^{a}	51.35±3.58^{a}	51.30±3.36^{a}	47.56±3.08^{b}	49.85±3.08^{ab}
Non-carcass percentage (%)	25.00±2.05^{c}	24.34±2.41^{c}	26.08±3.26^{bc}	25.74±2.66^{bc}	27.15±2.68^{ab}	28.95±2.39^{a}
Head	5.64±0.88^{bc}	6.39±0.63^{a}	4.94±0.80^{d}	5.12±0.73^{cd}	5.44±0.70^{bcd}	5.89±1.15^{ab}
Wet skin	8.09±0.96^{b}	6.69±0.96^{c}	8.72±1.28^{b}	7.91±1.26^{b}	7.03±0.70^{c}	9.96±2.09^{a}
Feet	2.20±0.39^{b}	2.34±0.32^{b}	2.37±0.37^{b}	2.41±0.41^{ab}	2.67±0.33^{a}	2.29±0.25^{b}
Tail	0.19±0.03^{d}	0.37±0.06^{a}	0.32±0.07^{b}	0.31±0.06^{b}	0.25±0.06^{c}	0.33±0.08^{b}
Red offal	3.32±0.90^{bc}	2.66±0.97^{c}	3.84±1.24^{b}	3.83±1.12^{b}	5.55±2.10^{a}	3.56±0.42^{b}
Green offal	5.54±1.22^{b}	5.88±1.11^{ab}	5.88±1.22^{ab}	6.16±1.63^{ab}	6.20±1.22^{ab}	6.93±0.97^{a}

the carcass. The relatively high proportion of non-carcass weight was due to higher proportions of feet and red offal. Meanwhile, the relatively high proportion of non-carcass weight of local buffalo was a result of higher proportions of skin and green offal (Table 2).

Effect of age: As shown in Table 3, live and carcass weights of local cattle and buffalo tended to increase with increasing age. However, significant ($p<0.05$) differences occurred only between the I_3 and I_0 age groups. Whilst the carcass dressing percentage was relatively constant, the non-carcass percentage tended to decrease with increasing age. The decreasing percentage of non-carcass dressing might be due to the decreasing percentages of head, wet skin and feet. The percentages of tail and green offal remained relatively constant and the differences in red offal percentages did not follow any particular pattern with increasing age. A similar result has been reported that increasing slaughter age from 18-30 months could increase live and carcass weights but not the dressing percentage of beef steers finished on natural pastures[31].

Effect of sex: As shown in Table 4, local beef carcass and non-carcass productivities were markedly affected by sex, with male animals having significantly ($p<0.05$) higher percentages of carcass and non-carcass components of head, wet skin and feet but lower percentages of green offal. Saka *et al.*[32] reported similar results that male cattle yielded higher carcass weight and percentages and lower green offal percentages compared to female cattle.

Effect of body fatness: The body fatness of the large ruminants obviously affected the carcass and non-carcass productivities (Table 5). This study suggests that an increased body fatness score resulted in increased slaughter and carcass weights. The animals with BFS 4 had significantly ($p<0.05$) heavier slaughter and carcass weights than those of BFS 2 and the animals with BFS 3 had significantly ($p<0.05$) heavier slaughter and carcass weights than those of BFS 2. Increased body fatness of local cattle and buffalo was not necessarily followed by an increase in carcass percentage and decrease in non-carcass percentage. The animals with BFS 4 had significantly ($p<0.05$) higher carcass dressing percentages than those of BSF 3 and BFS 2. The animals with BFS 3 had significantly ($p<0.05$) lower non-carcass percentages compared to those with BFS 2, while the non-carcass percentages were similar between BSF 2 and 4 animals. The differences in the non-carcass percentage between body fatness categories were mainly due to differences in the proportions of wet skin, feet, tail and offal (Table 5).

Table 3: Effect of age by dentition of local cattle and buffalo on slaughter, carcass and non-carcass characteristics

	Age group by dentition				
Parameters	I_0	I_1	I_2	I_3	I_4
Slaughter weight (kg)	314.27±89.66^{b}	345.90±88.96^{ab}	354.07±90.80^{a}	366.34±95.62^{a}	353.45±74.10^{a}
Carcass weight (kg)	161.01±51.14^{b}	177.41±46.39^{ab}	180.35±49.60^{ab}	183.54±51.17^{a}	180.59±43.24^{ab}
Dressing percentage (%)	50.80±3.84	51.32±3.36	50.75±3.19	49.97±4.57	50.82±3.68
Non-carcass percentage (%)	26.12±2.04^{ab}	26.46±2.47^{a}	24.94±2.73^{bc}	24.84±3.36^{c}	24.76±3.60^{c}
Head	5.55±0.57^{a}	5.43±0.80^{ab}	5.26±0.89^{ab}	5.21±0.90^{ab}	5.09±0.99^{b}
Wet skin	8.10±1.30^{a}	8.07±1.25^{a}	7.75±1.15^{ab}	7.32±1.42^{b}	7.58±1.21^{ab}
Feet	2.55±0.33^{a}	2.45±0.39^{a}	2.44±0.41^{a}	2.22±0.47^{b}	2.20±0.35^{b}
Tail	0.31±0.06	0.29±0.07	0.28±0.07	0.28±0.07	0.30±0.09
Red offal	3.80±1.59^{ab}	4.22±1.64^{a}	3.51±1.13^{b}	3.73±1.12^{ab}	3.74±1.04^{ab}
Green offal	5.79±1.31	5.98±1.36	5.68±1.75	5.96±2.14	6.40±2.03

Table 4: Effect of sex of local cattle and buffalo on slaughter, carcass and non-carcass characteristics

	Sex	
Parameters	Male	Female
Slaughter weight (kg)^{ns}	348.14±90.97	339.61±81.94
Carcass weight (kg)	180.18±50.15^{a}	166.35±41.69^{b}
Dressing percentage (%)	51.54±3.49^{a}	48.98±3.27^{b}
Non-carcass percentage (%)	25.87±2.52	25.47±3.26
Head	5.52±0.75^{a}	4.75±0.87^{b}
Wet skin	7.99±1.27^{a}	7.37±1.26^{b}
Feet	2.45±0.38^{a}	2.26±0.45^{b}
Tail^{ns}	0.29±0.08	0.29±0.06
Red offal^{ns}	3.80±1.49	4.00±1.08
Green offal	5.81±1.29^{b}	6.80±1.73^{a}

Table 5: Effect of the body fatness score of local cattle and buffalo on slaughter, carcass and non-carcass characteristics

	Body fatness score		
Parameters	BFS 2 (thin)	BFS 3 (medium)	BFS 4 (fat)
Slaughter weight (kg)	316.14±88.42^{c}	347.81±83.24^{b}	407.38±73.35^{a}
Carcass weight (kg)	154.90±45.27^{c}	180.45±45.26^{b}	212.46±40.05^{a}
Dressing percentage (%)	48.88±3.63^{b}	51.81±3.31^{a}	52.13±2.48^{a}
Non-carcass percentage (%)	26.58±2.59^{a}	25.25±2.30^{b}	25.87±3.77^{ab}
Head^{ns}	5.46±0.88	5.28±0.82	5.24±0.85
Wet skin	7.63±1.27^{b}	7.85±1.17^{ab}	8.25±1.65^{a}
Feet	2.51±0.35^{a}	2.36±0.43^{b}	2.30±0.37^{b}
Tail	0.31±0.07^{a}	0.29±0.07^{a}	0.26±0.07^{b}
Red offal	4.07±1.64^{a}	3.57±1.02^{b}	4.36±1.79^{a}
Green offal	6.59±1.42^{a}	5.89±1.41^{b}	5.46±1.44^{b}

This study suggests that for traditional market specifications, improving the cattle body fatness category from BSF 2 (thin condition) to BSF 3 (medium condition) could increase slaughter weight by 31.6 kg and the carcass dressing percentage by 2.93% from 48.88- 51.81%, while improving the cattle body fatness category from BSF 3 (medium condition) to BSF 4 (fat condition) could increase slaughter weight by 59.7 kg but only increase the carcass dressing percentage by 0.3%, from 51.81-52.13%. Similar results have been reported by Ismail *et al.*[6] that increased fatness of small-frame Bali and Madura cattle were followed by increases in their carcass dressing percentage. Overall, increasing cattle body fatness increased slaughter and carcass weights and hence the saleable beef yield and economic value[33].

This study provided more accurate data on carcass and non-carcass productivities from local cattle and buffalo at the national level because their carcass dressing procedures were based on a national standard carcass definition[10]. Variations due to breed, age and sex did occur in carcass and non-carcass characteristics; nevertheless, their carcass productivities were regarded as low to medium category. The low to medium carcass productivity of local cattle and buffalo suggests that domestic beef production in the short term could be increased by increasing the body fatness score through a fattening programme based on concentrate rations[20,24,26].

CONCLUSION

Of the local beef cattle and buffalo, local crossbred cattle are predominantly slaughtered in public abattoirs due to their higher carcass weight and dressing percentage. The majority of the slaughtered animals were in thin or medium body condition and only a small proportion of them were in fat condition. Breed, age, sex and body fatness score markedly influenced the slaughter weight and carcass weight and percentage.

SIGNIFICANCE STATEMENT

This study finds that for traditional market specifications, improving the cattle body fatness category from BSF 2 (thin condition) to BSF 3 (medium condition) could increase slaughter weight and the carcass dressing percentage, while improving the cattle body fatness category from BSF 3 (medium condition) to BSF 4 (fat condition) could increase slaughter weight but only increase the carcass dressing percentage. This study is very useful for farmers and beef producers because it provided more accurate information on carcass and non-carcass productivities from local cattle and buffalo at the national level.

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