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Original Research

On Farm Evaluation of Milk Production and Composition Performance of Horro Cattle Breed in Western Oromia, Ethiopia

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Abstract

This study examined the milk output and composition of Horro cattle herds managed by farmers in Horro district, Horro Guduru Wollega zone, Oromia, Ethiopia. Two-year milk output and composition data were collected from 220 Horro cows owned by 64 households. SAS GLM was used to analyze the data. The average daily milk yield (DMY), lactation milk yield (LMY), 305 days' milk yield (305DMY), and lactation length (LL) were 1.5±0.01liters, 419.8±4.45liters, 474.5±3.50liters, and 284.1±0.15days, respectively. The mean (LSM±SE) percentages for protein, fat, solid, not fat, and total solid were 3.5%, 6.0%, 8.8%, and 14.0%, respectively. Calving year, season, parity, and lactation stage affected all milk supply. Season, lactation stage, and parity substantially impacted fat, solids, not fat (SNF), and total solids (TS) (P<0.01). The average daily milk supply was highest in the first 3 months of lactation, while fat and TS % peaked after 6 months. Short-rainy-season and third-party cows produced the most milk. Non-genetic factors considerably impacted the traits investigated in this study, showing that improved management can dramatically improve attributes. In the current study, milk production performance varied widely among herd members, suggesting selection could increase it.

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INTRODUCTION

Cattle are vital to the efficiency of Ethiopia's agricultural sector, which accounts for the bulk of the country's GDP. Cattle supply a lot of the drought power needed to grow crops, and they also play a big role in national development plans to increase milk and meat production. According to Ulfina et al. (2005), they have multiple cultural and social purposes in Ethiopia, including serving as collateral for informal loans and producing much-needed income during times of scarcity. According to the CSA (2011), Ethiopia is home to an enormous 52.1 million cattle. The poor milk and meat yields are mostly attributable to the lack of selective breeding for a specific output, which is more prevalent in temperate Bos taurus breeds. This is true despite the enormous numbers. Natural selection, however, has endowed them with adaptive features that allow them to endure brutal environments while simultaneously producing milk, draught strength, and calves. So far, 27 different breeds of cattle have been found in Ethiopia, and the Horro is one of them (Rage, 2007). The dung or manure of these cattle breed is utilized as a fertilizer for crop cultivation, in addition to providing draught power, meat, and milk. The economic relevance of Horro cattle is likely due to their adaptation to their environment and long-term natural selection for tick resistance (Stein et al., 2011). Horro cattle are mostly employed for their draught capabilities. The majority of the resources needed by rural farmers in the Horro district come from Horro cattle (Agere, 2008). According to Mekonnet et al. (2012), this breed was originally from the Horro region in the Horro Guduru Wollega zone in western Ethiopia. Their owners in rural areas rely on them for nearly all of their needs, including food production, drought resistance, crop pulling, financial stability, social status, and wealth preservation. There have been zero study interventions on the breed's performance under the farmer management system, despite the breed's substantial contribution to rural farmers' livelihoods. Up until now, research stations have been the sites of nearly all investigations. Although useful as a starting point, the limited research findings derived from one-time fast surveys do not represent the breed's actual performance. As a result, researchers in West Oromia, Ethiopia's Horro Guduru Wollega zone, wanted to see how well the Horro Cattle breed produced milk and what kinds of nutrients were in that milk.

MATERIALS AND METHODS

Description of the study area

In two pastoral areas (PAs) in western Ethiopia's Oromia region, specifically in the Horro district and the Horro Guduru Wollega zone, researchers gathered data. The two PAs considered for the monitoring project were Oda Buluk and Didibe Kistana. The Horro district is located around 310 kilometers west of Addis Ababa, Ethiopia, or 64 kilometers north-west of the Bako Agricultural Research Centre. Approximately 2,000 to 3,100 meters above sea level is the elevation of the Horro district. The district experiences annual rainfall of 900 to 1800 mm and temperatures ranging from 11.80 to 22.70 °C. The soil type most commonly found in the Horro district is sand loam. Of the Horro district, 49.8% is in the highlands, 48.96% is in the midlands, and 1.24% is in the lowlands (Duguma et al., 2012). In this region, you'll experience three separate seasons: the rainiest from June to September, the driest from October to February, and the shortest from March to May.

Animal care and site selection

In order to identify the homes and monitoring sites for the study, a preliminary survey was carried out among the PAs in the district. The two peasant associations (PAs) chosen for the monitoring project were Oda Buluq and

Didibe Kistana, based on the results of the reconnaissance survey. Furthermore, the availability of the PAs for the monitoring project and their representativeness to the Horro cattle population were additional criteria for their selection. A total of 68 homes were chosen for the monitoring project. Of these, 36 were from Oda Buluq and 32 were from Didibe Kistana. Each household had to own two lactating pure Horro cows and be ready to take part. In order to gather pertinent information from the selected farmers, a systematic questionnaire was also utilized. We surveyed specific families to learn about their cow herd sizes and compositions, as well as their cattle production systems, trait preferences, limitations on livestock production, and potential solutions.

A total of 220 cows, belonging to 68 different households, were monitored throughout the various stages of lactation and pregnancy for this study. To ensure the well-being of all the cows utilized in this study, a comprehensive management system was devised. Daytime herding of cows on shared grazing areas occurred during cropping season to protect crops from potential harm. Animals were allowed unrestricted access to communal grazing areas and crops throughout the dry season. There are two distinct varieties of pastures in the Horro district: public and private. Due to its limited size, the exclusive grazing area is home to just a select few animal species, such as working oxen. Working oxen are given this protected feed first thing in the morning and again before bed during the ploughing season. Plastic ear tags were used to identify all the calves and cows. Permanent marker was used to inscribe unique numbers on the tags. In order to gather this data, enumerators were hired who were natives of the different PAs. Enumerators received training on both the best practices for data collection and the specific pieces of information to seek out.

Information genesis and processing

By keeping tabs on 220 cows managed by farmers, we were able to compile data on milk performance. The animals were observed for a duration of two years. The cows were milked by hand into a clean container after being stimulated by the calf for approximately one minute in order to measure the milk output. From the beginning of the lactation period until the end, the milk that was collected from the cow twice a day was measured using a graduated cylinder and recorded in a logbook.

The daily milk yield was used to calculate the average yield, the yield during lactation, and the yield after 305 days. Cows that did not have at least six test-day milk records were not included in the analysis in order to ensure that the maximum record size was met. For this data study, we used 1908 milk records after excluding those that did not meet the criteria. For the purpose of estimating milk's chemical makeup, 180 samples of milk were collected. Following a thorough mixing, 100 millilitres of milk per milking were collected in sterile bottles and stored in an icebox at less than 5ºC. They were then swiftly transported to the Holeta Agricultural Research Centre, Dairy Laboratory, and kept in a deep-freezing cabinet at -5ºC until they were needed for analysis. During the two seasons, milk samples were taken from cows at various parities and phases of lactation in order to find out how non-genetic factors affected the composition of milk.

Milk production should be adjusted to 305 days. Some of the cows in this study had a lactation period of fewer than 305 days, while others had a longer period. Lactation durations of more than 305 days—or even a year—are observed in animals that do not exhibit the estrus indication while nursing. This study calculated the duration of lactation for each cow up until the date on which the mother accepted her calf for nursing. But up until the 305-day mark, milk production was documented.

Examination in a laboratory

Three methods were employed in the analysis of milk composition: the Gerber method for determining fat %, the formaldehyde titration method for determining protein percentage, and the oven-drying method for determining total solids percentage. By deducting the fat percentage from the total solids percentage, the solids percentage (and not the fat %) was calculated (ILCA, 1993).

Examinations grounded in statistics

To analyse the data, the statistical analysis system's General Linear Model (GLM) procedures were utilized (SAS, 2004). When dealing with least squares means including more than two variables, Tukey's Kumar test was employed for separation. The following parameters were assessed: daily milk yield (DMY), lactation milk yield (LMY), total solids (TS) %, fat percentage, protein percentage, and 305-day milk yield (305DMY-computed). Parity, calving season, and year of calving (2009/10 and 2010/11) were the independent variables that were fitted to the analysis model. The present research divided the year into three distinct seasons: the primary rainy season (June–October), the dry season (November–February), and the brief rainy season (March–May). This study only included primiparous cows or those who have given birth up to their fourth parity. Due to the fact that cows undergo numerous changes throughout the course of lactation, the stages of lactation were classified as early, mid, and late lactations. Depending on the stage of lactation, it stops at different times: early (1-3 months), mid (4-6 months), and late (≥7 months). Fixed effects for LMY, 305DMY, and LL included calving year, calving season, and cow parity. The milk composition was determined by fitting fixed effects for the following variables: parity (first, second, or third), stage of lactation, sampling season (major rainy season or dry season), and milk composition.

RESULTS AND DISCUSSION

Milk production performance

Table 1 displays the LSM±SE, or least squares mean, for the milk output of Horro cattle. Horro cows had an average DMY of 1.5±0.01 litters, an LMY of 419.8±4.45 litters, and 305 DMY (305 litters) of milk. The variables DMY, LMY, 305DMY, and LL were significantly affected (at least at $p<0.05$) by the year of calving, the season of calving, parity, and stage of lactation. Except for LL, all of the variables measured in this study showed improved performance in cows that calved in 2009 or 2010. A shorter LL was seen in 2010/11 calves compared to 2009/10 calves. In relation to the season, DMY, LMY, 305DMY, and LL were noticeably greater (p<0.01) in cows that gave birth during the brief wet season. Findings from this study corroborate those from other studies that have shown the impact of calving year (Nega and Sendros, 2000; Million and Tadelle, 2003). The variance in annual precipitation and its distribution may explain why there were noticeable differences in milk yield between the study years. This could be because feed availability varied from year to year.

Table 1

Least squares mean (± SE) of effects of year, season, parity, and lactation stage on milk production traits

Effects	DMY (lt)	LMY (lt)	305DMY (lt)	LL (days)
Overall mean	1.5±0.01	419.8±4.45	474.5±3.50	284.1±0.15
N	1908	1908	1002	212
R^2	0.75	0.78	0.88	0.25
CV (%)	15.9	15.2	7.4	12.9
Year	***	***	***	*
2009/10	1.5±0.01[a]	446.2±5.81[a]	465.2±4.24[a]	291.1±3.20[a]
2010/11	1.4±0.01[b]	377.7±7.53[b]	410.4±5.83[b]	280.7±4.15[b]
Season	***	**	***	***
Main rainy season	1.6±0.01[b]	438.2±7.10[b]	499.8±5.16[a]	267.3±3.91[c]
Dry season	1.0±0.01[c]	280.3±8.40[c]	301.2±7.33[b]	285.8±4.63[b]
Short rainy season	1.7±0.01[a]	517.3±8.73[a]	512.3±5.74[a]	305.2±4.81[a]
Parity	***	***	***	*
1st parity	1.3±0.01[d]	354.6±8.26[c]	400.9±6.50[c]	267.8±4.55[c]
2nd parity	1.5±0.01[b]	427.0±8.84[b]	451.1±6.48[b]	288.8±4.87[b]
3rd parity	1.6±0.01[a]	493.7±9.41[a]	492.0±6.37[a]	303.2±5.19[a]
4th parity	1.4±0.01[c]	372.5±10.65[c]	407.2±8.27[c]	278.8±5.87[c]
Stage of lactation	**	NA	NA	NA
Early lactation	1.7±0.01[a]	-	-	-
Mid lactation	1.5±0.01[b]	-	-	-
Late lactation	1.1±0.01[c]	-	-	-

*N=Number of records; *P<0.05, **P<0.01, ***P<0.001; DMY=Daily milk yield; My=Lactation milk yield; 305DMY = 305 days' milk yield; LL=Lactation length*

Crossbred Holstein Friesian and local cows also showed a substantial season effect on DMY, LMY, 305DMY, and LL (Table 1), according to Goshu and Mekonnen (1997) and Aynalem (2006). Some studies in the literature (e.g., Rege, 1991; Million and Tadelle, 2003) disagree with the present report on the season effect. Cows who gave birth during the brief rainy season milked for an additional 37.9 days, while those that gave birth during the major rainy season milked for an additional 19.4 days. Tropical animals' performance is likely to fluctuate with the seasons due to changes in diet amount and quality (Javed, 1999). Table 1 shows that the longest LL and largest DMY, LMY, and 305DMY yields were often produced by cows that calved during the brief rainy season, which is March to May. During the dry season, the researchers found the lowest DMY, LMY, and 305DMY. Possibly because there was less natural fodder available at the end of the dry season, milk output was lowest then. Additionally, milk production and feed intake might have been negatively affected by the dry season's high temperatures. Alternatively said, it is possible that Horro cattle's reduced milk production performance during the dry season was due to a mix of nutritional insufficiency and high temperatures. The lactation lengths of cows that gave birth during the main rainy season were noticeably shorter ($p<0.001$) compared to those that gave birth during dry and short rainy seasons. This could be because cows that gave birth during the lengthy wet season and then milked during the subsequent long dry period dried out sooner, leading to a shorter duration of lactation.

According to previous research (Million and Tadelle, 2003; Aynalem, 2006; Ahmed et al., 2007), the data on DMY, LMY, 305DMY, and LL corroborate the strong impact of parity ($P<0.001$). From the first to the third parity, milk production performances rose, and then they gradually fell. This result agrees with previous research on the Kereyu cow breed in Ethiopia's Oromia region's Fentalle area (Shiferaw, 2006). Milk production on Ayrshire-Brown Swiss-Sahiwal hybrids in Kenya decreases after the third parity, according to Martinez (1988) and Mackinnon et al. (1996). One of the major non-genetic reasons of variation in milk output, according to Goshu and Mekonnen (1997), is parity discrepancies. Kefena (2006) found no significant influence of lactation on milk supply in Borana cows kept at Holeta Agricultural Research Center. This finding contradicts that finding. Cows that hadn't yet achieved maturity may have used part of the nutrients for bodybuilding, which would explain why their milk supply was so low during the first parity. Cows' diminished milk production capabilities in the fourth parity can be attributable to a combination of factors, including a decline in the quantity and strength of milk secreting cells as a result of aging and physical frailty.

The DMY varied significantly ($p<0.001$) according to the stage of lactation. There was an upward trend in milk yield for the first three months, but then it started to decline. Consistent with the findings of Stanton et al. (1992), who also noted a decline in milk production following peak, the present investigation found the same thing. According to the authors, by the time the lactation stage came to a close, the milk yield performance of the Holstein Friesian herd in southern Malawi had progressively dropped to 12.5 kg/day.

According to findings in the literature on Horro cattle breeds used in farmers' management systems, the current average DMY, LMY, and 305 DMY are generally equivalent (Alganesh, 2002; Lemma, 2005; Agere, 2008). Jiregna (2007) provided results for the same breed from a different location, the Danno section of West Shewa Zoo, although they are higher. However, Mulugeta et al. (1993) reported higher results for the same breed of cows kept at the Bako Agricultural Research Center, therefore the current study's findings are lower. Daily milk yield was 2.41 liters and lactation milk yield was 508 liters (ranging from 100 to 1155 kg), according to the authors. It is thought that variations in management lead to variable reactions within the same breed, which explains why the on-station data and current production levels diverge. The research center's level of improvement interventions over the years is indicated by the considerable disparities in the performances of the same breed of cows handled on-farm compared to those managed on-station.

A combination of lengthy lactation durations and high daily milk outputs determines total milk production. Horro cows had an average lactation duration of 284.1 ± 3.40 days. If you look at other studies on Horro cattle (Beyene, 1992; Jiregna, 2007; Agere, 2008), you'll see that this finding is similar. In contrast to previous studies on the same breed (229 days; IAR, 1991) and the indigenous Barka cattle breed (279 days; Million and Tadelle, 2003), the present study found a mean lactation length of 284 days. Nevertheless, the lactation duration in this study is less than the 411 days recorded for N'Dama cattle in Gambia (Agyemang et al., 1999). Compared to the international standard of 305 days for lactation, the current study's results are more in line with the standard, falling just approximately 21 days short. A feed scarcity in the region might explain why the study found extended lactation duration; this would explain why the cows in the study experienced delayed heat and how the calf's persistent sucking affected the results. Longer lactation duration in dairy cows is achieved by extending the suckling time, which in turn slows ovarian follicle formation and prolongs the anoestrus period (Chandler and Robinson, 1974). Thus, it's possible that the Horro cattle breed's short lactation length typical of indigenous tropical cow breeds isn't an issue for productivity.

Table 2 shows that there were significant individual differences among the cows that participated in this study. Average LMY from the on-farm herds was 617 liters for the top 10% of cows and 558 liters for the top 25%. This shows that the top 10% of cows generated 198 liters more milk than the average of the herd (419 liters), and that the top 25% of cows produced 59 liters more milk than the average of the herd. Conversely, Table 1 shows that the average lactation milk yield was 139 liters lower than what the top 25% of the herd in the current study achieved. This variation in average performance within the same herd under the same management approach shows that there are a lot of differences at the breed level in terms of phenotypes. These differences can be used to increase performance through genetic selection over the long term.

Table 2

Variability in lactation milk yield and daily milk yield of Horro cows under farmer management system

Parameter	Lactation milk yield (lt.)	Daily milk yield (lt.)
Mean	419.84	1.47
Best 10%	617.00	2.01
Best 25%	558.16	1.86
Table.2 continues..		
Maximum	822.75	2.23
Minimum	115.20	0.50

Milk composition

The current study found that the overall least squares mean (LSM±SE) percentages for protein, fat, solid not fat (SNF), and total solids (TS) were 3.5±0.01, 6.0±0.01, 8.9±0.01, and 14.0±0.01, respectively, as shown in Table 3. The Horro cattle herd's milk composition was significantly affected ($p<0.001$) by the sampling season in this study. There is a substantial difference ($p<0.001$) in the percentages of protein, fat, SNF, and TS between the dry and wet seasons.

This study's findings that season has a substantial impact on fat % contradict those of Aynalem (2006). The author found no statistically significant relationship between the calving season and the fat percentage of Borana cows or Borana-Holstein Friesian hybrid cows. Consistent with our findings, previous research has shown that the season has a substantial impact on fat percentage (Zelalem et al., 2006). On the other hand, the dry season showed a high fat percentage, according to Zelalem et al. (2006). The abundance of Cynodon aethiopicus (Diffa) and Cynodon dactylon (Chokorsa) grass, which are highly prized for their high fat production, during the rainy season in the research location may explain the high fat content found during this time of year (Agere, 2008). So, it's reasonable to assume that the milk's fat content might change depending on the season and the feed available. The protein % of Borana cows was shown to be significantly affected by the season ($p<0.01$), according to Mesfin and Getachew (2007). Borana cows who gave birth during the wetter part of the year had a greater protein content than their dry-season counterparts, the authors claim. The current research found that compared to cows born during the dry season, those whose calves were born during the wet season contained more protein. Contrary to what Aynalem (2006) found, which was that cows whose calves were born during the dry season had higher SNF and TS percentages than those whose calves were born during the rainy season, the higher percentages of SNF and TS gained during the wet season are different. While this study covers a larger portion of the East Wollega zone, the results for protein, fat, SNF, and TS as percentages are consistent with those of Alganesh (2002) for the same breed. Compared to previous studies that used on-station management, this one found a reduced percentage of fat in the same breed (Zinash et al., 1989).

In contrast to previous research on central highland cows, the current study found a higher fat percentage in Borana, Borana-Holstein Friesian, and Borana-Jersey crosses than in Tsehay (1998), Mesfin and Gojam (2000), Aynalem (2006), and Zelalem et al. (2006). Variations in cow genetics, dietary management, and physiological state might account for the disparity in fat % results. The present study also found that Horro cow milk still had a considerably greater fat percentage, even when managed using traditional farmer methods. Horro cows have a relatively high fat percentage, which may suggest that combining them with temperate breeds will result in milk with a greater fat percentage (better milk quality).

Table 3

Least squares means and standard errors of milk composition (%) in Horro cattle breed as influenced by season, stage of lactation and parity

Effect and level	Protein (%)	Fat (%)	SNF (%)	TS (%)
Overall	3.47±0.01	6.04±0.01	8.88±0.01	14.02±0.01
N	180	180	180	180
R^2	0.34	0.75	0.35	0.70
C.V (%)	11.3	8.1	10.3	6.9
Season	***	***	***	***
Dry season	$3.2±0.04^a$	$5.3±0.05^a$	$7.5±0.08^a$	$12.7±0.10^a$
Wet season	$3.7±0.04^b$	$6.8±0.05^b$	$8.7±0.08^b$	$15.4±0.10^b$
Parity	NS	**	*	*
1st parity	3.5±0.05	$5.8±0.06^c$	$8.4±0.12^a$	$13.8±0.13^b$
2nd Parity	3.5±0.05	$6.0±0.06^b$	$8.4±0.12^a$	$13.9±0.13^b$
3rd parity	3.5±0.05	$6.3±0.06^a$	$8.2±0.12^b$	$14.3±0.13^a$
Stage of lactation	*	**	*	*
Early lactation	$3.4±0.05^b$	$5.7±0.06^b$	$8.2±0.12^a$	$13.5±0.12^b$
Mid lactation	$3.5±0.05^a$	$6.0±0.06^b$	$8.1±0.12^a$	$13.8±0.12^b$
Late lactation	$3.5±0.05^a$	$6.3±0.06^a$	$8.0±0.12^b$	$14.8±0.12^a$

*NS= Not significant; *P<0.05; **P<0.01and ***P<0.001. Least squares mean with the same superscript in the same column for the same effect indicate non significance*

Milk composition, with the exception of protein content, was significantly affected by cow parity (P<0.01) (Table 3). There was no significant difference in protein % (P > 0.05) among parity. The third-parity cow has the highest fat percentage compared to the first- and second-parity cows. Here, the lowest fat percentage was found in first-parity cows. Protein content was likewise found to be unaffected by parity, according to Aynalem (2006). One possible explanation for the rising fat percentage with increasing parity is that, according to genetic constraints, the cow's mammary gland must reach complete development before milk may be secreted.

Consistent with the current result, Aynalem (2006) found that in Ethiopian Borana and Borana-Holstein Friesian crossbred cows had a greater fat content in the third parity than in the previous parities. Cows in their first pregnancy had the greatest mean % of SNF. Contrarily, TS had the fewest cows in their first kidding season. The average TS% was greatest in third-parity cows. The percentages of fat and TS increased as the cow parties progressed from the first to the third. Consistent with previous research, this study found that parity had a substantial impact on milk composition (1991). As cows age, the SNF content of their milk declines irregularly, according to Yadav et al. (1989). According to Foley et al. (1974), the primary reason for the drop in SNF from the beginning to the later stages of lactation is the decrease in milk's lactose concentration. The fact that different members of the same breed produce milk with different compositions suggests that better within-breed selection could lead to significantly higher quality milk.

Fat, protein, SNF, and TS content in milk were significantly impacted by lactation stage. In the last stages of breastfeeding, there was an abundance of protein, fat, and TS. But the SNF percentage went down as lactation progressed, being highest in the beginning. The findings are in line with those of Mech and Rajkhowa (2007), who also found that the fat and TS content of Mithun cows increased significantly throughout the lactation stage. Additionally, Egbowon (2004) found that as lactation progressed, the fat proportion in milk increased. The current study found that milk output was highest in the early stages of lactation, whereas fat percentages were highest in the late stages, suggesting an inverse relationship between the two.

CONCLUSIONS

The current study's findings corroborate those of earlier on-farm investigations into the milk production and composition of Horro cows managed by farmers. Nevertheless, compared to earlier on-station studies for the identical breed, the present study's milk output and milk composition were lower. Indicative of management variations and maybe influenced by selection efforts thus far, herds of the same breed kept on stations perform better than those kept on farms.

Season was one of nearly all non-genetic variables that significantly affected milk output and milk composition in this study. If these non-genetic influences can be mitigated, it could mean that a great deal of progress is possible. Any plan for improvement could benefit from taking these non-genetic factors into account.

There were large individual differences in milk production performance within the herds studied here, suggesting that selection could lead to improvements in this feature. This study's findings on lactation duration suggest that, under the present agro-ecology and management circumstances, the Horro cow breed may not be constrained in production by the short lactation duration typically associated with indigenous tropical cattle breeds.

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DECLARATION

The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article materials.

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