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Article

Some chemical and biochemical results of traditionally prepared yak dried meat (borts)

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Abstract

This study aimed to determine some chemical and biochemical properties of traditionally prepared yak dried meat from Duut soum, Khovd province, Mongolia. The moisture, protein, fat, mineral content, amino acid composition, and fatty acid profile of the dried meat samples were analyzed. Results showed that the dried meat contained 7.36% moisture, 79.43% protein, 6.4% fat, and 4.3% minerals. The essential amino acids accounted for 45.85% of the total amino acids, with high levels of leucine (5.8%) and lysine (6.31%). In terms of fatty acids, the dried meat contained 35.57% saturated fatty acids, 48.26% monounsaturated fatty acids, and 15.99% polyunsaturated fatty acids. Among the polyunsaturated fatty acids, linolenic acid was the most abundant at 5.99%. Compared to beef jerky, traditionally prepared yak dried meat has similar moisture and mineral content but a higher protein content, indicating that it is a nutritious meat product with significant dietary value.

Keywords: *Fatty acids, amino acids, protein, nutritional value*

Introduction

Yaks are distributed across 132 soums in 13 provinces of Mongolia, primarily in mountainous and forest-steppe regions [1]. Over 50% of yaks inhabit areas above 2,000 meters above sea level, about 40% live at altitudes between 1,600 and 2,000 meters, and they utilize pastures and water sources unsuitable for other livestock. Raised under traditional management conditions, yaks are economically beneficial animals that produce various products [2].

Yak meat is rich in myoglobin, which oxidizes easily upon exposure to atmospheric oxygen, giving the meat a reddish-brown color. Yak fat contains high levels of carotene, a precursor to vitamin A, resulting in a bright yellow hue. Additionally, the meat has relatively coarse fibers and a firmer texture, with minimal marbling of fat within the muscle. However, these characteristics do not indicate lower quality; rather, they reflect a well-balanced fat-to-protein ratio and richness in protein and vitamins. Drying and preserving yak meat is a traditional method long practiced by the Mongolian people. dried meat (dried meat) is a durable, nutritious, and nourishing product that embodies the history and culture of the Mongolian ethnic group as one of its traditional red meat products. The objective of this study is to determine certain chemical and biochemical indicators of traditionally prepared yak dried meat, clarify its nutritional value, and verify the quality of this traditional product. Recent research (e.g., Jingjing et al., 2025) suggests that Mongolian yak dried meat, sourced from natural pastures and characterized by ecological purity, holds significant potential as a healthy, premium snack in the Chinese market [18]. Therefore, a detailed chemical and biochemical analysis of this traditional product is crucial for scientifically substantiating its market value.

Materials and methods

In November 2024, samples were collected from yak meat in Duut soum, Khovd province and prepared using traditional drying methods. The fully dried meat samples were obtained in April for laboratory analysis. Chemical composition quality analysis and fatty acid profile determination of the dried meat were conducted at the SAMO Institute of Food Science and Industrial Research of Mongolia. Amino acid composition analysis was performed by Pony Testing International Group in Hohhot, Inner Mongolia, China. The total sample size was n=6. Moisture content was determined according to MNS 6477:2014, fat content according to MNS 5035:2020, protein content according to MNS ISO 937:1984, and mineral content according to MNS ISO 936:2003. Amino acid composition was analyzed using high-performance liquid chromatography (HPLC). The fatty acid composition of yak dried meat was determined following the MNS CA3 18:2016 standard. The total fatty acid composition was analyzed using a Shimadzu gas chromatography (GC) system equipped with an FID detector and an HP-FFAP column (30 m length, 0.32 mm diameter, 0.25 μm film thickness). The column temperature was set at 120°C, and the detector temperature at 250°C. Hydrogen flow rate was set at 40 mL/min, oxygen at 400 mL/min, with a 1 mL sample injection. Fatty acids were identified by comparison with the Supelco FAME 37 mixed standard and expressed as a percentage of total fatty acids.

Results and Discussion

General Chemical Parameters

According to the research results, the analysis of general chemical indicators of traditionally prepared yak dried meat shows significant changes in its core chemical composition compared to raw meat. Specifically: moisture content drastically decreased from 69.11% to 7.36%, while protein content significantly increased from 21.67% to 79.43%. This is a typical phenomenon during the drying process, where water content decreases and dry matter becomes concentrated. Meanwhile, fat content slightly decreased (8.06% → 6.395%), while mineral content (1.16% → 4.335%) and caloric value (159.2 → 375.25 kcal) increased. These changes indicate that dried meat is a nutrient-dense and shelf-stable product. Indicators such as protein, minerals, and caloric value in the dried meat increased by 3-4 times compared to raw meat.

Table 1.

Results of the determined general chemical parameters

№	Chemical parameters	Methods	Raw Yak Meat	Yak dried meat
1	Moisture , %	MNS 6477:2014	69.11	7.36
2	Fat, %	MNS 5035:2020	8.06	6.395
3	Protein, %	MNS ISO 08:2009	21.67	79.43
4	Mineral, %	MNS ISO 936:2003	1.16	4.335
5	Calories, kcal	CA3 08:2009	159.2	375.25

When comparing the chemical indicators of our dried meat samples with the results of other studies from recent years, several notable similarities can be observed. In the study by Ganbat and Enkhtuya (2020), traditionally prepared yak dried meat had a moisture content of 8.5% and a protein content of 76.8%, which closely align with the results of our study (moisture 7.36%, protein 79.43%). This indicates that traditional drying methods are stable, effective, and preserve similar chemical compositions across different regions [13]. In an international study by Wang, Li, and Liu (2021), the protein content of yak dried meat was found to be 3–4 times higher than that of raw meat, which matches our findings. In our study, protein content increased by approximately 3.7 times (21.67% → 79.43%), further validating this globally recognized research conclusion [4]. When compared to the technical requirements for dried meat and dried meat specified in the MNS 1074:2019 standard, our dried meat samples not only met all key indicators but also demonstrated superior performance. For example, both moisture (⩽20%) and protein (⩾ 40%) content exceeded the limits specified in the standard [12].

Amino Acid Composition

The essential amino acid content in yak dried meat increased significantly across all types during the traditional processing from raw meat to dried meat. The total content rose from 8.37 to 29.61, approximately a 3.5-fold increase, reflecting the concentration of protein components due to moisture loss during drying. Particularly, the levels of essential amino acids such as lysine (6.31), leucine (5.825), and valine (3.5) remain notably high, indicating that dried meat is a high-quality protein source.

Table *2*.

Essential amino acid results

Essential Amino Acids			
(S/N)	Amino acid	Raw Yak Meat	Yak dried meat
1	Isoleucine	0.94	3.2
2	Methionine	0.41	1.91
3	Valine	1.01	3.5
4	Leucine	1.68	5.825
5	Phenylalanine	0.84	2.955
6	Threonine	0.84	3.105
7	Lysine	1.88	6.31
8	Histidine	0.77	2.805
	Total	8.37	29.61

The essential amino acid content in our study increased by 3- to 4-fold during drying, which aligns with conclusions from international research. For example, a study by Fan et al. (2024) noted that the rise in amino acid content in dried yak meat is directly related to moisture loss—a phenomenon that fully explains the results presented in our Table -2 [14]. Moreover, yak meat protein itself is of high quality, meeting the recommended standards of the FAO (Fan shinyi et al., 2025). During the processing into dried meat, this quality becomes even more pronounced, with key amino acids such as lysine and leucine remaining at high levels [16]. Similarly, the content of non-essential amino acids also changed markedly, increasing from 9.87 to 34.975. Notably, very high levels of glutamate (9.81) and aspartate (6.00) were observed. These amino acids play a crucial role in forming the taste and aroma of meat, acting as flavor enhancers.

Table *3*.

Non-Essential amino acid results

Non-Essential Amino Acids			
(S/N)	Amino acid	Raw Yak Meat	Yak dried meat
1	Glutamate	2.87	9.81
2	Aspartate	1.76	6
3	Glycine	0.87	3.09
4	Alanine	1.14	4.11
5	Proline	0.62	2.73
6	Serine	0.7	2.54
7	Arginine	1.32	4.6
8	Tyrosine	0.59	2.095
	Total	9.87	34.975

In our study, glutamate and aspartate, which are flavor-enhancing amino acids, dominated among the non-essential amino acids. This dominance aligns with the general trend in research on the taste and aroma of yak meat. For example, a study by Han et al. (2025) identified glutamate and aspartate in yak meat as key substances directly related to its unique, delicate flavor and aroma, which helps explain the high content of these amino acids in our dried meat samples [15]. The drying process concentrates these flavor-enhancing compounds, making it one of the fundamental factors in creating the distinctive taste of dried meat. The amino acid study revealed that essential amino acids account for 45.85% of the total amino acids in the dried meat. An essential amino acid content exceeding 40% indicates the high quality of the dried meat protein [3]. Among the essential amino acids, leucine (5.8%) and lysine (6.31%) are present in particularly high amounts. Lysine is a crucial amino acid for growth and organ function. Research by Chinese researchers also shows that dried yak meat is rich in lysine and leucine, which is consistent with our study's results [4]. Zhang and Chen's (2024) study indicated that the protein quality of dried yak meat, particularly its essential amino acids, accounted for 39.45% of the total amino acids, while our study results showed a higher proportion of 45.85%.

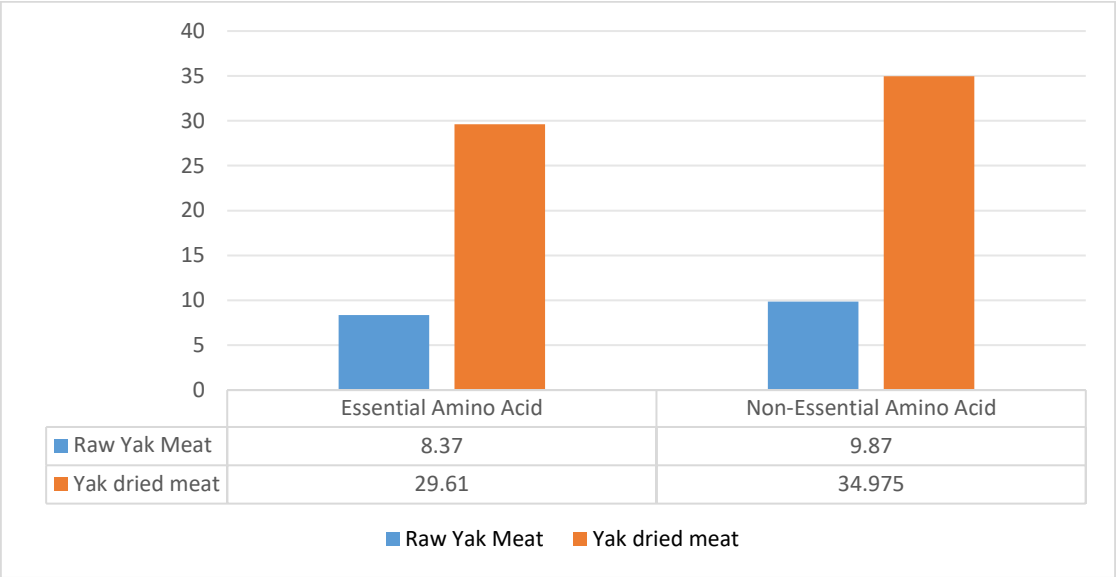

Figure 1 Total amino acid content

The total amino acid content in dried yak meat increased significantly compared to raw meat, with both essential and non-essential amino acids rising approximately 3.5-fold.

Fatty acid composition

The saturated fatty acid (SFA) content in yak dried meat is 35.57%, which is 4.1% higher than that of raw meat. Among the saturated fatty acids, palmitic acid (17.3%) and butyric acid (16.63%) are present in the highest amounts.

Table *4*.

Saturated Fatty Acid Content (SFA), %

Saturated fatty acid content (SFA)			
Formula	Fatty acid	Raw Yak Meat	Yak dried meat
C4:0	Butyric	9.21	8.06
C6:0	Caproic		
C8:0	Caprylic		
C10:0	Capric	0.12	0.1
C11:0	Undecanoic		
C12:0	Lauric		

Saturated fatty acid content (SFA)			
Formula	Fatty acid	Raw Yak Meat	Yak dried meat
C13:0	Tridecanoic		
C14:0	Myristic	1.97	1.73
C15:0	Pentadecanoic	0.26	0.24
C16:0	Palmitic	17.3	16.63
C17:0	Heptadecanoic	1	1.03
C18:0	Stearic	1.18	7.63
C20:0	Arachidic		0.06
C21:0	Henicosanoic		
C22:0	Begenic		
C23:0	Tricosanoic	0.12	
C24:0	Lignoceric	0.27	0.09
	Total	31.43	35.57

Regarding the changes in Table 4 (SFA) and Table 6 (PUFA): In our study, PUFA decreased while SFA (especially stearic acid) increased, which is consistent with the findings of Ding et al. (2021). Their research noted that when yak meat undergoes thermal processing such as drying or roasting, PUFA content tends to decrease while SFA content increases [17]. This is attributed to the poor oxidative stability of PUFAs. Although the total PUFA content in our dried meat samples decreased, the slightly increased levels of stable EPA and DHA align with another research outcome. Specifically, it has been highlighted that yak meat is characterized by higher levels of omega-3 fatty acids (EPA, DHA) compared to other types of beef [16]. The drying process appears to have been beneficial in preserving these healthy fatty acids.

Monounsaturated fatty acids (MUFA) accounted for 48.26%, and the MUFA content in yak meat and dried meat *was similar. Among these, oleic acid was the most abundant, constituting 46.75%.*

Table *5*.

Monounsaturated fatty acid content (MUFA), %

Monounsaturated fatty acid content (MUFA)			
Formula	Fatty acid	Raw Yak Meat	Yak dried meat
C14:1	Myristoleic	0.35	0.12
C15:1	Pentadecanoic	4.4	0.57
C16:1	Palmitoleic	0.58	0.45
C17:1	Heptadecanoic	0.12	0.2
C18:1	Oliec	42.11	46.75
C20:1	Gadoleic		0.08
C22:1	Erucic	0.51	0.09
C24:1	Nervonic		
	Total	48.07	48.26

The high retention of total MUFA content, particularly oleic acid, during the processing into dried meat highlights the advantageous fat quality of yak meat. As emphasized in numerous studies, the dominance of monounsaturated fatty acids (MUFA) in yak meat fat defines its healthy characteristics [15][16]. The results of our study demonstrate that traditional drying methods can effectively preserve this healthy fatty acid composition. MUFAs such as oleic acid are more stable than SFAs and more resistant to oxidation, which is beneficial for the long-term storage of dried meat.

Polyunsaturated fatty acids (PUFA) account for 15.99%. Among the PUFAs, linoleic acid (C18:2), an essential omega-6 fatty acid for the human body, constitutes 9.3% in raw meat and 5.99% in dried meat. Meanwhile, the omega-3 fatty acid alpha-linolenic acid (C18:3(3)) accounts for 0.29% in raw meat and 0.25% in dried meat, and eicosapentaenoic acid (EPA, C20:5(3)) accounts for 1.38% in raw meat and 1.68% in dried meat.

Table 6.

Polyunsaturated fatty acid content (PUFA), %

Polyunsaturated fatty acid content (PUFA)			
Formula	Fatty acid	Raw Yak Meat	Yak dried meat
C18:2	Linoleic	9.3	5.99
C18:3(3)	a-linolenic	0.29	0.25
C18:3(6)	γ-linolenic	2.34	1.96
C20:2	Eicosadienoic	0.07	0.19
C20:3(6)	Icosatrienoic		
C20:3(3)	Eicosatrienoic	6.24	4.76
C20:4(6)	Arachidonic		
C20:5(3)	Eicosapentaenoic (EPA)	1.38	1.68
C22:2	Docosadienoic		
C22:6(3)	Docosahexaenoic (DHA)	0.75	1.16
	Total	20.37	15.99

Although total PUFA decreased, the increased levels of EPA (ω3) and DHA (ω3), which are particularly important for the human body, align with data from the literature. Yak meat is renowned for its nutritional quality and is a good source of EPA and DHA [16]. During the drying process, the slight decrease in total fat content and the concentration of other components in the dry matter may have led to an increase in the relative concentration of these fatty acids. Changes in fatty acid composition during meat processing are commonly observed. For instance, the reduction of polyunsaturated fatty acids (PUFA) during the cooking and roasting of mutton reflects a similar principle to the decreased PUFA content in our yak dried meat, highlighting the impact of processing methods (Tserenkhand & Tumurtogtokh, 2013) [19].

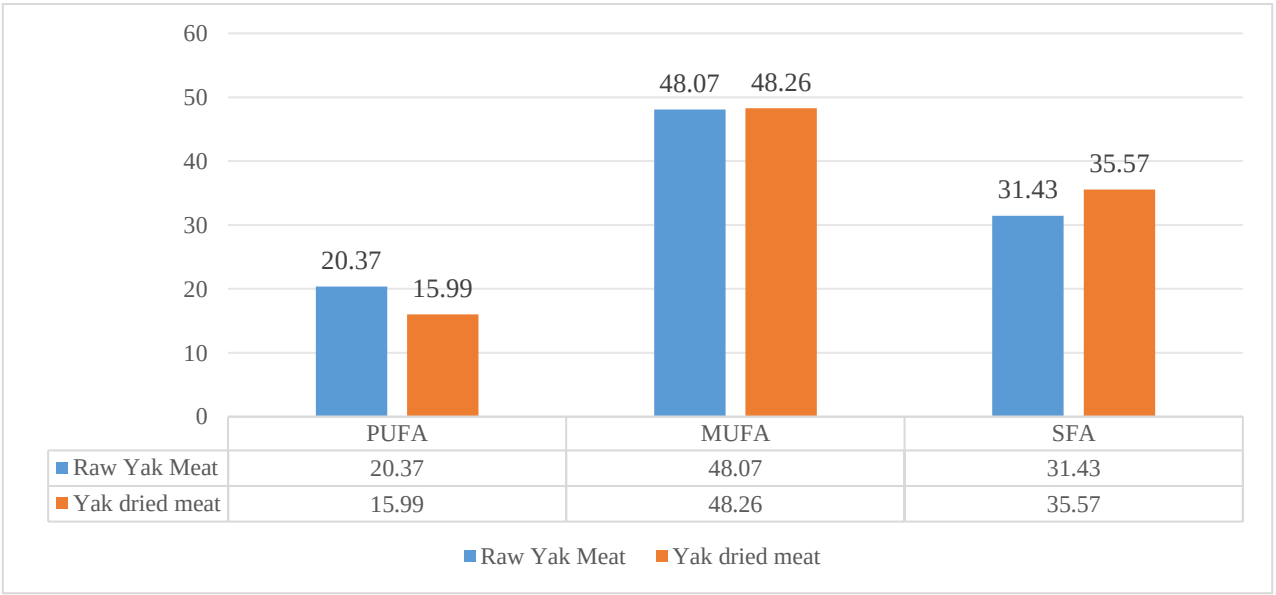

Figure 2 Total fatty acid content

This diagram compares the fatty acid composition (SFA, MUFA, PUFA) percentages of raw meat and dried meat. In raw meat, the fatty acid content was SFA 31.43%, MUFA 48.07%, and PUFA 20.37%, whereas after processing into dried meat, it changed to SFA 35.57%, MUFA 48.26%, and PUFA 15.99%. The PUFA/SFA ratio of the borts is 0.45. The PUFA/SFA ratio of 0.45 in our study's dried meat perfectly matches the acceptable range (0.4-0.5) for a healthy diet according to the UK Department of Health (1994) [5]. Furthermore, the study by Zhang and Chen (2024) concluded that an omega-6 to omega-3 ratio of 1 is an excellent indicator of meat quality and is beneficial for cardiovascular health. Our study found an omega-6 to omega-3 ratio of 1.01, which is almost identical to this result [6].

Conclusion

The chemical analysis of traditionally prepared yak dried meat revealed the following key changes during the processing from raw meat to dried meat: a significant decrease in moisture, a 3-4 fold increase in the concentration of protein and amino acids, stable retention of the fatty acid profile, and preservation of healthy fatty acids such as omega-3 (EPA, DHA). These changes contribute to the product's high nutritional value, good bioavailability, and suitability for long-term storage. Traditionally prepared yak dried meat is characterized by high protein content (79.43%), low fat (6.4%), a balanced amino acid profile, and an optimal fatty acid ratio (PUFA/SFA ratio P:S = 0.45; omega 6 to omega 3 ratio n-6/n-3 = 1.01), indicating that it is a high-quality meat product. The traditional dried meat- making technique is an integral part of Mongolian history and culture. Going forward, it is necessary to further improve the quality and safety of dried meat, develop value-added products, and enhance its competitiveness in the market.

Authors' contribution

Jingjing writing original draft preparation, Husiletu and Enkhjargal contributed supplementary materials and eview and Tserenkhand writing review, editing and supervision. All authors have read and approved the final manuscript.

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