



RESEARCH PAPER

# Study of physico-chemical properties and amino acid profiling of buffalo paneer and acid whey

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## Abstract

Whey is a liquid by-product obtained from coagulated milk products like paneer and cheese. The operational cost of the effluent treatment plant is increased by the measures taken for the safe disposal of whey. Importance of the nutritional value of whey and the properties of its constituents has been the subject of numerous studies over the past few years. The present study was undertaken to study the physico-chemical properties and amino acid profiling of buffalo paneer and acid whey produced out of it. Due to the availability of both essential and non-essential amino acids, the study revealed that paneer and acid whey from buffalo milk were both nutritionally significant. There is a significant presence of both essential and non-essential amino acids even in the acid whey which is generally considered a waste needs to be thought of and further researched for its benefits and utilization in the best possible ways.

## Keywords

Buffalo milk, paneer, whey, essential amino acids, nonessential amino acids, HPLC

## Introduction

Paneer is a high-protein dairy product from India and is consumed widely by vegetarians across the nation, Paneer is one of the softer types of cheese. The production of Paneer in India is projected to be 150,000 tonnes per year or 1% of the country's total milk output. Indian cuisine values paneer as it is a rich source of high-quality protein, fat, and minerals.

Whey is the milk serum that is left over after straining and curdling of milk for the production of paneer using various approved acidulants such as citric acid. The colour of whey will be greenish-yellow depending on the type and grade of milk used. Due to its unique nutritional and functional features, scientists have incorporated whey into various edibles. When compared to several other protein sources including corn, soy, and wheat, whey proteins are one of the most accessible proteins and reservoirs of

important amino acids (Singh et al. 2014). Whey protein-based amino acids are more easily absorbed and used than free amino acid solutions. Leucine, isoleucine, and valine, three branched-chain amino acids are also abundant in it. These three branched-chain amino acids (BCAAs) are the essential metabolic regulators of lipid metabolism, protein homeostasis, and glucose levels. They are directly metabolized by skeletal muscles, boosting protein synthesis, maintaining muscular mass, and producing energy during extended activity (Rocha-Mendoza et al. 2021). Due to its profound health benefits, paneer and whey has been studied in various aspects like incorporation of spices and herbs (Neethu and Nair 2020), inclusion of zinc complex (Prasad et al. 2022), biofuel production (Das et al. 2016) and edible films and coatings (Kandasamy et al. 2021). Hence, study of physico-chemical characteristics and nutritional content of paneer and its by-product whey made from buffalo milk was the primary objective of the study.

## Materials and methods

### Procurement of raw materials

Buffalo milk was procured from the Dairy plant of KVASU Mannuthy (Thrissur). Food Grade Citric Acid was purchased from the local market of Thrissur. All reagents (analytical and HPLC grade) & standards were purchased from Merck (Merck KGA, Darmstadt, Germany).

### Characterization of whey and paneer

Paneer and whey samples were analysed for various physicochemical parameters including pH using digital pH meter, acidity by titrimetric method, total solids, fat by Acid Digestion Method [Werner Schmidt Method], protein by Micro Kjeldahl unit: Kelplus supra-LX VA, ash using muffle furnace and amino acid profile using AminoQuant Method as per FSSAI.

### Statistical analysis

All the parameters were repeated in triplicate and the data was analyzed with its Mean  $\pm$  Standard Deviation (SD) using IBM SPSS software (Snedecor and Cochran 1989).

## Result and discussion

### Physico-chemical properties of Buffalo paneer

The data of physico-chemical properties of buffalo paneer was presented in Table 1. The results depicts that the buffalo paneer had, moisture ( $41.75 \pm 0.12\%$ ), crude protein ( $24.72 \pm 0.03\%$ ), SNF ( $29.72 \pm 0.5$ ), fat ( $27.67 \pm 0.12\%$ ), lactose ( $1.82 \pm 0.21\%$ ), pH ( $6.32 \pm 0.01$ ), acidity ( $0.30 \pm 0.02\%$ ), ash ( $2.04 \pm 0.07\%$ ) and total solids ( $58.24 \pm 0.33\%$ ). These results were in accordance with (Dhankhar 2014).

**Table 1.** Physico-chemical properties of Buffalo paneer and Acid whey.

Parameters	Buffalo paneer	Acid whey
Moisture	$41.75 \pm 0.12$	$93.21 \pm 0.13$
Crude Protein	$24.72 \pm 0.03$	$1.58 \pm 0.02$
Solids-Not-Fat (SNF)	$29.72 \pm 0.5$	$4.31 \pm 0.05$
Fat	$27.67 \pm 0.12$	$2.43 \pm 0.13$
Lactose	$1.82 \pm 0.21$	$3.76 \pm 0.21$
pH	$6.32 \pm 0.01$	$5.26 \pm 0.02$
Acidity	$0.30 \pm 0.02$	$0.19 \pm 0.03$
Ash content	$2.04 \pm 0.07$	$0.37 \pm 0.05$
Total solids	$58.24 \pm 0.33$	$6.78 \pm 0.31$

Data are expressed as means  $\pm$  standard deviation (%).

### Physico-chemical properties of acid whey

The data of physico-chemical properties of Acid whey was presented in Table 1. The results of acid whey were moisture

( $93.21 \pm 0.13\%$ ), crude protein ( $1.58 \pm 0.02\%$ ), SNF ( $4.31 \pm 0.05\%$ ), fat ( $2.43 \pm 0.13\%$ ), lactose ( $3.76 \pm 0.21\%$ ), pH ( $5.26 \pm 0.02$ ), acidity ( $0.19 \pm 0.03\%$ ), ash ( $0.37 \pm 0.05\%$ ) and total solids ( $6.78 \pm 0.31\%$ ). These results were in accordance with acid whey analyzed by (Goyal and Gandhi 2009; Shukla et al. 2013; Rocha-Mendoza et al. 2021).

### Amino acid profile in Buffalo paneer

The HPLC analysis of buffalo paneer by AminoQuant Method revealed the quantitative components of essential and non-essential amino acids, leucine ( $9.1 \pm 0.01$ ) was major essential amino acid. Followed by the means of Lysine ( $9.0 \pm 0.04$ ), Phenylalanine ( $7.2 \pm 0.03$ ), Valine ( $7.1 \pm 0.01$ ), Isoleucine ( $6.1 \pm 0.05$ ), Threonine ( $5.1 \pm 0.03$ ), Methionine ( $1.2 \pm 0.02$ ), Tryptophan ( $1.0 \pm 0.01$ ) and Histidine ( $0.7 \pm 0.01$ ). Glutamic acid ( $16.4 \pm 0.03$ ) was found to be a major non-essential amino acid. Followed by Aspartic acid ( $8.3 \pm 0.02$ ), Proline ( $7.2 \pm 0.05$ ), Serine ( $4.3 \pm 0.03$ ), Tyrosine ( $4.2 \pm 0.05$ ), Alanine ( $3.8 \pm 0.02$ ), Cysteine ( $2.6 \pm 0.01$ ), Arginine ( $2.4 \pm 0.04$ ) and Glycine ( $1.3 \pm 0.01$ ).

**Table 2.** Essential amino acids analyzed by Amino Quant Method- HPLC in Buffalo paneer and Acid whey (g/100 g of paneer and whey).

Parameters	Buffalo paneer	Acid whey
Leucine	$9.1 \pm 0.01$	$10.1 \pm 0.02$
Lysine	$9.0 \pm 0.04$	$8.7 \pm 0.02$
Isoleucine	$6.1 \pm 0.05$	$5.9 \pm 0.04$
Threonine	$5.1 \pm 0.03$	$6.3 \pm 0.05$
Histidine	$0.7 \pm 0.01$	$1.3 \pm 0.02$
Methionine	$1.2 \pm 0.02$	$1.9 \pm 0.03$
Phenylalanine	$7.2 \pm 0.03$	$3.2 \pm 0.01$
Tryptophan	$1.0 \pm 0.01$	$1.6 \pm 0.03$
Valine	$7.1 \pm 0.01$	$5.2 \pm 0.01$

Data are expressed as means  $\pm$  standard deviation.

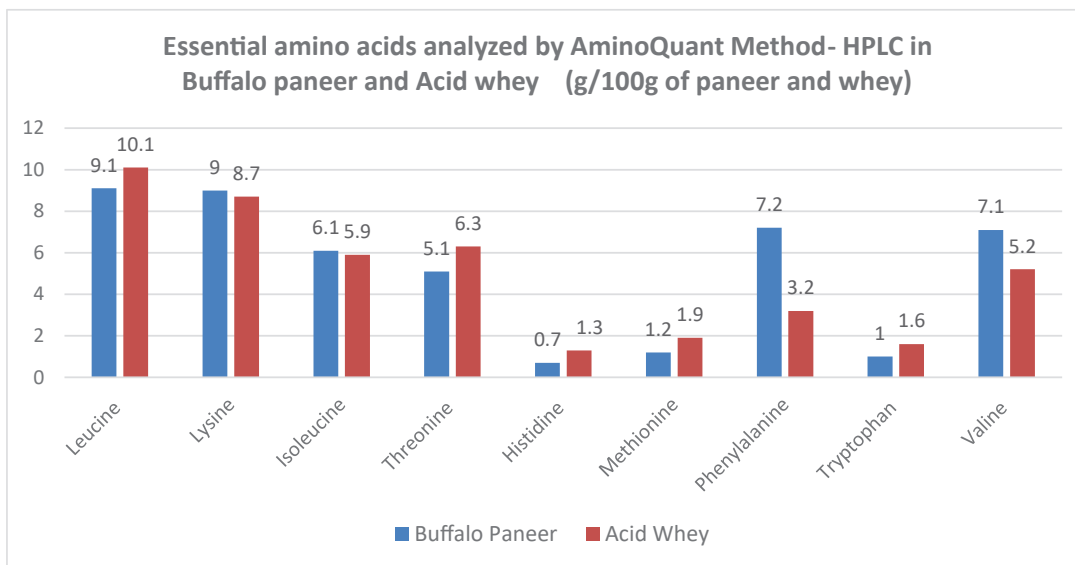
### Amino acid profile in acid whey

The HPLC analysis of acid whey by AminoQuant Method revealed the quantitative components of essential and non-essential amino acids (g/100 g), Leucine ( $10.1 \pm 0.02$ ) was major essential amino acid. Followed by Lysine ( $8.7 \pm$

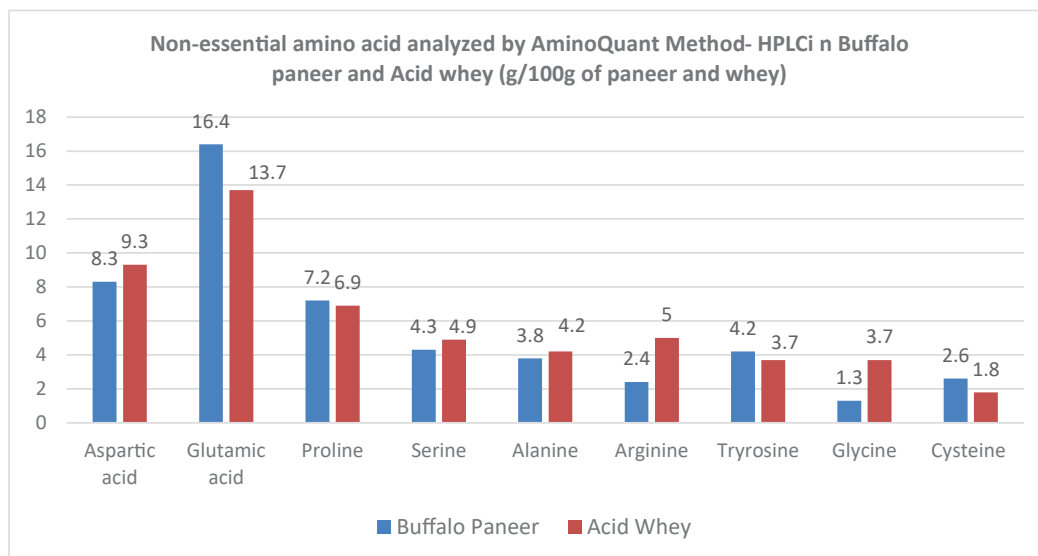
**Table 3.** Non-essential amino acid analyzed by Amino Quant Method- HPLC in Buffalo paneer and Acid whey (g/100 g of paneer and whey).

Parameters	Buffalo paneer	Acid whey
Aspartic acid	$8.3 \pm 0.02$	$9.3 \pm 0.04$
Glutamic acid	$16.4 \pm 0.03$	$13.7 \pm 0.02$
Proline	$7.2 \pm 0.05$	$6.9 \pm 0.03$
Serine	$4.3 \pm 0.03$	$4.9 \pm 0.01$
Alanine	$3.8 \pm 0.02$	$4.2 \pm 0.04$
Arginine	$2.4 \pm 0.04$	$5.0 \pm 0.03$
Tyrosine	$4.2 \pm 0.05$	$3.7 \pm 0.04$
Glycine	$1.3 \pm 0.01$	$3.7 \pm 0.05$
Cysteine	$2.6 \pm 0.01$	$1.8 \pm 0.02$

Data are expressed as means  $\pm$  standard deviation.



**Figure 1.** Essential amino acids analyzed by Amino Quant Method- HPLC in Buffalo paneer and Acid whey (g/100 g of paneer and whey).



**Figure 2.** Non-essential amino acid analyzed by AminoQuant Method- HPLC in Buffalo paneer and Acid whey (g/100 g of paneer and whey).

0.02), Threonine ( $6.3 \pm 0.05$ ), Isoleucine ( $5.9 \pm 0.04$ ), Valine ( $5.2 \pm 0.01$ ), Phenylalanine ( $3.2 \pm 0.01$ ), Methionine ( $1.9 \pm 0.03$ ), Tryptophan ( $1.6 \pm 0.03$ ) and Histidine ( $1.3 \pm 0.02$ ). Glutamic acid ( $13.7 \pm 0.02$ ) was found to be major non-essential amino acid similar to buffalo paneer. Followed by Aspartic acid ( $9.3 \pm 0.04$ ), Proline ( $6.9 \pm 0.03$ ), Arginine ( $5.0 \pm 0.03$ ), Serine ( $4.9 \pm 0.01$ ), Alanine ( $4.2 \pm 0.04$ ), Tyrosine ( $3.7 \pm 0.04$ ), Glycine ( $3.7 \pm 0.05$ ) and Cysteine ( $1.8 \pm 0.02$ ). These results were in accordance with acid whey analyzed by (Goyal and Gandhi 2009).

## Conclusion

The study showed that both paneer and acid whey from buffalo milk had higher nutritional significance due to their presence of essential and non-essential amino acids

as similar studies suggested. Further study on modification of amino acid content, would be useful to increase their biological value and digestibility. Acid whey should be considered as a valuable dairy by-product during paneer manufacturing and shall be utilized for the preparation of ready-to-drink whey beverage, protein concentrates, ready-to-mix beverage powder and can also be used in various functional foods to enhance the nutritional and physico-chemical properties of the product. By-product whey from manufacturing cheese and paneer can be utilized at maximum thereby preventing environmental pollution due to unsafe disposal. This paper would be useful for those who manufacture cheese and paneer at low quantity and has a problem of disposal of whey. Through this study, whey can be used as a fortificant to increase protein and amino acid content of various dairy and food products.

## Conflict of interest

The authors declare no conflict of interest.

## Author contribution

DR. Indu Balakrishnan: Conceptualization, Formal analysis, Data Curation, Writing - Review & Editing, Supervision, Resources. Vrindha Vinoj: Writing - Original Draft. Dharani Muthusamy: Formal analysis, Data Curation, Writing - Review & Editing, Supervision. Vyshak V L: Formal analysis, Writing - Review & Editing.

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