Proceedings of 30th Annual Conference of ASAN 2025, Abuja, Nigeria (104-107)

AMINO ACIDS AND FATTY ACIDS COMPOSITIONS OF MEAT AND MEAT PRODUCTS AND THEIR ANALYTICAL TECHNIQUES; A REVIEW

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Abstract

This review examines the amino acids and fatty acids compositions of meat and meat products, along with their analytical techniques. Proteins in meat contain twenty (20) amino acids, including twelve (12) essential ones critical for human nutrition, with variations observed across species (beef, lamb, pork). Analytical methods for amino acids involve extraction, deproteinisation, and chromatographic analysis. Fatty acids, primarily triglycerides and phospholipids are in abundance in meat, analysed via lipid extraction, methylation, and gas chromatography (GC). Key findings include species-specific profiles of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA), with palmitic (C16:0) and oleic (C18:1) acids dominating. Processing and storage significantly impact amino acids availability and fatty acids stability. The study underscores the importance of standardised analytical protocols to ensure accurate nutritional assessment of meat products.

Keywords: Amino acids, Fatty acids, Meats, and Analytical techniques

Description of Problem

Protein quality is mainly concerned with the availability of amino acids present in it. Amino acids function as the building blocks of the proteins. The nutritional value of meat varies considerably based on the presence and proportions of amino acids. Over 500 amino acids are known to exist among which only 20 are used to make the proteins. From these 20 amino acids, 12 are considered as the essential amino acids, as these could not be synthetised by the human body, so must be taken by the diet (1). The other eight are the non-essential amino acids that could be manufactured by the human body but only if their particular dietary sources are being ingested, otherwise, it could result in the protein malnutrition (1).

The quantification process of amino acids in samples involves three main stages: extraction, deproteinisation, and analysis. Extraction separates free amino acids from the insoluble muscle matrix by homogenising the sample in a solvent such as hot water, dilute hydrochloric acid, or phosphate buffers. The homogenised solution is then centrifuged, and the supernatant is filtered through glass wool to remove any remaining fats. Deproteinisation is achieved using chemical or physical methods, where proteins are precipitated by denaturation with strong acids like sulfosalicylic, perchloric, or trichloroacetic acids, or with organic solvents such as methanol, ethanol, or acetonitrile, leaving free amino acids in solution. Lastly, amino acids are analysed using spectrophotometric or chromatographic methods, such as high-performance liquid chromatography (HPLC) (2). For HPLC, amino acids are prepared to one or more derivatives of a compound to improve separation or detection. Cation-exchange HPLC separates non-

derivatives amino acids and derivatives them post-column, while reverse-phase HPLC is used for pre-derivatived amino acids (3). The essential and non-essential amino acids in groups of meat products are shown in Table 1.

Table 1: Essential and non-essential amino acids in meat

Amino acids (%)	Category	Beef	Lamb	Pork
Lysine	Essential	8.2	7.5	7.9
Leucine	Essential	8.5	7.2	7.6
Isoluecine	Essential	5.0	4.7	4.8
Cystine	Essential	1.5	1.5	1.2
Threonine	Essential	4.2	4.8	5.2
Methionine	Essential	2.2	2.4	2.6
Tryptophan	Essential	1.3	1.2	1.5
Phenylalanine	Essential	4.1	3.8	4.3
Arginine	Essential	6.4	6.8	6.6
Histidine	Essential	2.8	2.9	3.1
Valine	Essential	3.6	5.1	5.2
Proline	Non-essential	5.2	4.7	4.4
Glutamic acid	Non-essential	14.3	14.5	14.6
Aspartic acid	Non-essential	8.9	8.6	8.8
Glycine	Non-essential	7.2	6.8	6.0
Tyrosine	Non-essential	3.3	3.3	3.1
Serine	Non-essential	3.9	3.8	4.1
Alanine	Non-essential	6.3	6.2	6.4

Source: (4) and (5)

The essential and non-essential amino acid contents differ with the different category of meat. Amino acids in meat are derived from muscle proteins and exhibit species-specific variations. Essential amino acids like lysine and leucine are particularly abundant and play crucial roles in protein synthesis, immune function, and metabolic processes. Among non-essential amino acids, glutamic acid is predominant, contributing to flavour and serving as a neurotransmitter. The content of these amino acids in all the meat types could be affected by the application of processing techniques including heat and radiations, but only when the prolonged modes of these conditions are being applied (6). Sometimes the interaction of the other amino acids constituents with the proteins has put an effect on the availability of essential amino acids. Apart from the effect of the processing conditions, the storage had imparted its effect on amino acids, in case of canned meat (7).

Fatty acids in meat are primarily found in triglycerides (in fat depots) and phospholipids (in muscle tissues), with contributions varying based on total fat content. In muscles, phospholipids contribute between 10 to 40 % of the total fatty acids (8). Most fatty acids in meat contain between 14 to 20 carbon atoms in the molecule. The total content of saturated fatty acids (SFA) ranges between 30 to 50 % of the total fatty acids in most meat type. The main SFA are palmitic acid (C-16:0), stearic acid (C-18:0), and myristic acid (C-14:0). Palmitic acid is the most abundant (20 to 25 %) followed by stearic acid (5 to 20 %) of total fatty acids. About 35 to 50 % of fatty acids are monounsaturated, oleic acid (C-18:1) (30 to 45 %) being the main monounsaturated fatty acid (MUFA) followed by palmitoleic acid (C-16:1) (2 to 5 %) (9).

Fatty acid analysis in meat involves three steps: lipid extraction, preparation of fatty acid methyl esters (FAMEs), and gas chromatographic (GC) analysis. The critical step is the methylation of

fatty acids to produce FAMEs, which can be achieved using acid, base, boron trifluoride, or diazomethane, each with specific advantages. For FAME preparation, a meat sample (1 g fresh or 0.5 g dry/semi-frozen) is minced, and 200 mg is mixed with an internal standard (tridecanoic acid), potassium hydroxide, and methanol. The mixture is incubated at 55°C for 1:30 hours with intermittent shaking to ensure hydrolysis. After cooling, sulfuric acid is added, and the sample is incubated again for FAME synthesis. Following a second cooling, hexane is added to extract the FAMEs, which are separated by centrifugation and analysed using GC (10). Fatty acid compositions, SFAs, MUFAs, PUFAs concentrations of vary species are displayed in Table 2.

Table 2: Meat fatty acid composition of various species

Fatty acid (%)	Veal	Lamb	Pork	Chicken	Turkey
10.0 - Capric Acid (Decanoic Acid)	0.00	0.26	0.20	0.000	0.22
12.0- Lauric Acid (Dodecanoic Acid)	0.00	0.26	0.20	0.41	0.45
14.0 - Myristic Acid (Tetradecanoic Acid)	1.92	2.37	1.43	0.82	0.97
16.0 - Palmitic Acid (Hexadecanoic Acid)	23.56	23.75	24.34	21.72	21.53
18.0 - Stearic Acid (Octadecanoic Acid)	14.42	19.26	11.86	9.02	10.02
Other Saturated Fatty Acids	1.45	3.70	0.21	0.41	0.89
Total Saturated Fatty Acids	41.35	49.60	38.24	32.38	34.08
16.1- Palmitoleic Acid (Hexadecenoic Acid)	4.33	2.11	3.48	4.92	3.19
18.1 - Oleic Acid (Octadecenoic Acid)	39.42	42.22	45.40	31.15	31.33
Other Mono Unsaturated Fatty Acids	0.48	0.26	1.02	0.82	0.89
Total Mono Unsaturated Fatty Acids	44.23	44.59	49.90	36.89	35.41
18.2 - Linoleic acid	10.10	3.43	9.61	22.54	25.17
18.3 - α-Linolenic Acid (ALA)	0.48	1.85	0.41	0.82	1.26
20.4 - Arachidonic acid (AA)	3.85	0.53	1.43	3.28	2.30
Other Poly Unsaturated Fatty Acids	0.00	0.00	0.41	4.10	1.78
Total Poly Unsaturated Fatty Acids	14.42	5.80	11.86	30.74	30.51

(11)

SFAs are characterized by having no double bonds between the carbon atoms in their chemical structure, making them stable and typically solid at room temperature are essential for energy production. Total SFAs recorded greater percentage in lamb (49.60 %) while chicken recorded lower percentage (32.38 %). Excessive intake of SFAs increases the risk of cardiovascular related disease. PUFAs are characterized with multiple double bonds in their carbon chain, making them less saturated, which are critical for heart health, brain function, inflammation control, and cell membrane integrity. Chicken recorded higher percentage of 30.74 % while lamb recorded lower percentage of 5.80 %. However, PUFAs as essential nutrients are vulnerable to peroxidation and excessive intake can promote inflammation. Table 3 details PUFA and cholesterol in lean meat and offal, highlighting variations.

Conclusion and Application

The analyses of amino acids and fatty acids in meats revealed there compositions as influenced by species, part obtained. Essential amino acids like lysine and leucine and non-essential amino acids like glutamic acid and aspartic acids are predominant across meats type. Fatty acid profiles highlight the predominance of SFAs and MUFAs, while PUFAs being more abundant in poultry. Advanced techniques like HPLC and GC are indispensable for precise quantification of amino acids and fatty acids contents.

Table 3: Polyunsaturated fatty acids and cholesterol in lean meat and offal

Meat source	Cholesterol (mg/100g)	C-18:2	C-18:3	C-20:3	C-20:4	C-20:5	C-20:6
Mutton	81	2.4	2.4	-	-	Trace	-
Beef	62	2.1	1.4	Trace	1.1	Trace	-
Pork	71	7.5	1.0	-	Trace	Trace	1.1
Brain	2200	0.5	Nil	1.6	4.1	3.5	0.4
Pig's Kidney	415	11.6	0.4	0.5	6.72	Trace	-
Sheep's Kidney	399	8.2	4.1	0.6	7.2	Trace	-
Ox's kidney	401	4.9	0.6	Trace	2.7	-	-
Sheep's Liver	429	5.1	3.9	0.7	5.2	3.1	2.3
Pig's Liver	262	14.8	0.4	1.2	14.4	2.4	3.9
Ox's Liver	271	7.5	2.4	4.5	6.5	5.4	1.3

Sources: (12); (13), C-18:2 - Linoleic acid, C-18:3 - α-Linolenic Acid (ALA), C-20:3 - Dihomo-γ-Linolenic Acid (DGLA), C-20:4 - Arachidonic acid (AA), C-20:5 - Eicosapentaenoic Acid (EPA), C-20:6 - Docosahexaenoic Acid (DHA).

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