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Nutrient profiling of traditionally sun-dried *Acetes*

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ABSTRACT

An attempt was made to study the nutrient profile of traditionally sun-dried *Acetes* with respect to its proximate composition, amino acids, fatty acids, minerals and heavy metals. From the results, it was found that dried *Acetes* contained $19.00 \pm 0.70\%$ moisture, $48.29 \pm 0.64\%$ crude protein, $16.05 \pm 0.52\%$ ash and $3.62 \pm 0.09\%$ crude fat. Biopolymer content in dried *Acetes* showed 10% chitin. Amino acid profile of dried *Acetes* confirmed that it could serve as a significant source of essential amino acids. Fatty acid profile revealed 9, 12-otadecadecioic acid (17.08%), docosahexaenoic acid (DHA) (15.69%), eicosapentaenoic acid (EPA) (13.45%) and docosanoic acid (11.75%) as the major fatty acids. Mineral profiling indicated the presence of P, Ca, K, Mg, Na and Fe. Heavy metal analysis indicated the presence of Cd, Cu, Pb and Zn. However, harmful metals like cadmium and lead were found to be low. From microbiological quality analysis of dried *Acetes*, the total plate count and faecal coliforms count were found to be 4.1×10^3 cfu g⁻¹ and 35 MPN per 100 ml, respectively while *Staphylococcus aureus* colonies were not detected. Results of the study indicated that dried *Acetes* was not processed properly and hygienically as revealed by its content of high moisture and faecal coliforms, respectively. Further, based on proximate composition, amino acids, fatty acids and mineral profile, it can be concluded that dried *Acetes* can be a good source of health beneficial nutrients.

Keywords: *Acetes*, Amino acids, Biopolymer, Fatty acids, Microbial quality, Minerals, Nutrient profiling

Overfishing, together with climate change, is altering the kind and amount of fish found on the Indian coast. Several species of fish and shellfish which were considered as low cost trash species and discarded previously, are now fetching more price due to the decline in the catch of commercial species from the wild. This emphasises the need to give proper importance to the low cost species for adequate value realisation through proper processing under hygienic conditions. The non-penaeid shrimp *Acetes* spp. that constitutes about 20% of the total marine shrimp landings of India is one such group gaining importance. It is popularly known as “paste shrimp” and belongs to the family Sergestidae. It is widely distributed in different parts of the world and is found along the coast of many countries bordering the Indian Ocean. In India, most of this shrimp is landed along the north-west coast in the states of Gujarat and Maharashtra where it is locally known as ‘jawla’. It is small-sized, growing to a maximum size of 40 mm, weighing 0.2-0.5 g and highly perishable, spoiling quickly due to autolysis by proteolytic enzymes. Most of the *Acetes* landed is sold to the fish meal manufacturers at a very low price. Only a small quantity of fresh *Acetes* is dried in the landing centers of Gujarat and Maharashtra. But due to unhygienic conditions during drying, the commercially dried *Acetes* is contaminated with sand and other extraneous matter and has a very high bacterial load. Moreover, during peak landing seasons, there is insufficient space onboard fishing vessels to

properly ice and store the *Acetes* harvested, due to which a lot of quality deterioration takes place before drying. After drying, the product is marketed without proper packaging which further deteriorates the quality of the dried material. Only a small quantity of good quality dried *Acetes* is packed separately and sent to the markets of Punjab, Haryana and North-eastern states. Dried *Acetes* has export market in Japan, Sri Lanka and other countries. In spite of its increasing importance, no work has been carried out on the nutritional aspect of dried *Acetes*. Attempts have been made to prepare *Acetes* powder (Mulbagal *et al.*, 1980; Jagushthe, 1989) and to separate flesh from *Acetes* (Garg *et al.*, 1977; Patil, 2000). Jagushthe (1989) prepared products such as *sevu*, *chakli* and noodles using powdered *Acetes*. Damle *et al.* (1989) prepared a cooked and dried product namely ‘kropukudhang’ from fresh whole *Acetes*. As the ground *Acetes* meat has a high moisture content and shell portion, Patil (2000) prepared *Acetes*-fish fingers using ground and pressed *Acetes* meat and fish meat in a combination of 1:1 ratio. Zynudheen *et al.* (2004) investigated the quality of fresh and dried *Acetes* with respect to its proximate composition. However, there are no studies on the complete nutrient profiling of traditionally sun-dried *Acetes*. Hence the present study attempted complete nutrient profiling of traditionally sun-dried *Acetes* which can be useful for developing new ready to eat products from *Acetes*.

For the experiment, traditionally sun-dried *Acetes* was procured from the commercial drying site of Alibuag, Raigad District, Maharashtra, India. The samples (500 g each) were packed in high density polyethylene pouches and brought to the fish processing laboratory within 3 h. The sun-dried *Acetes* was then used for analyses of proximate composition, nutrient profile, chitin content, microbial load and heavy metal content.

Chemicals and media for the study *viz.*, sodium chloride, trichloroacetic acid, anhydrous sodium sulphate, potassium chloride, sodium hydroxide, total plate count agar, chloroform, hydrochloric acid, n-heptane, sodium bicarbonate, potassium iodide and sodium thiosulphate were procured from Merck (Mumbai, India) while boron trifluoride was from Merck (Schuchardt OHG, Hohenbrunn, Germany). All chemicals were of analytical grade.

Moisture, crude protein and ash content were determined according to AOAC (1995) and crude fat was determined as per Folch *et al.* (1957). The microbial quality of dried *Acetes* was analysed with respect to total plate count, *Staphylococcus aureus* count and faecal coliforms as per the standard methods (BIS, 2011). Faecal coliforms and *Staphylococcus aureus* count was determined by MPN method. For nutrient profiling, minerals were determined employing Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) (Model Thermo Electron IRIS INTREPID II XSP DUO, Germany). For this, the sample was digested in a microwave digester (Milestone, Shelton, Italy), digested sample was aspirated into the flame and the corresponding absorption of the characteristic radiation by each element was recorded. Values were expressed as percentage of whole dried *Acetes* samples. Further, total amino acid composition was determined following the method of Ishida *et al.* (1981) using a Shimadzu chromatograph LC-10AT vp high performance liquid chromatograph (HPLC) equipped with an ion exchange column, quaternary pump, a 20 μ l injection valve and a fluorescence detector. Mobile phase A contained sodium citrate (13.31g l⁻¹) and ethanol (70 ml l⁻¹) (pH 3.5) and B had sodium citrate and 4N NaOH (pH 9.8). The flow rate was constant at 0.4 ml min⁻¹ and the column temperature was set at 60°C. The fluorescence excitation and emission wavelengths were 340 and 450 nm, respectively. Samples were hydrolysed in 6N HCl in evacuated sealed tubes at 110°C for 24 h. After derivatisation by O-phthalaldehyde, amino acids were identified and quantified by comparison of their retention times with those of standards (Sigma). The results were expressed in terms of per 1000 residues.

Chitin content was estimated as per AOAC (1975). *Acetes* sample (2 g) was boiled with 5% (w/v) NaOH at 90°C for 30 min. It was filtered through Whatman filter paper and the residue obtained was washed till alkali free. This residue was digested with conc. H₂SO₄ and nitrogen content

was estimated as per the Kjeldhal distillation method. Chitin content was calculated by multiplying the chitin nitrogen with conversion factor 14.5 and was expressed on whole *Acetes* basis.

Total lipid was extracted from *Acetes* by Folch method and the fatty acid methyl ester (FAME) was prepared from the isolated lipids by heating with the methanolic NaOH first and then with BF₃ methanol for esterification. n-heptane (5 ml) was added to recover the methyl esters in organic phase. The mixture was washed with saturated NaCl solution and two phases were separated using a separating funnel. The upper n-heptane phase was pipetted out and stored in 10 ml all glass vials until further analysis. Fatty acid profile of dried *Acetes* was determined using a gas chromatography-mass spectrometry (GC-MS) instrument (Model GCMS-QP 2010, Shimadzu, Japan) equipped with a DB-WAX (30 m 0.25 mm ID; 0.5 μ m film thicknesses) capillary column (Cromlab, S. A). Helium was used as the carrier gas. Injector and detector temperature was set at 250°C. Injection was performed in split mode (1:15). The column temperature was programmed initially at 50°C for 2 min and then it was increased at a rate of 10°C per min to a final temperature of 230°C. FAME was separated at constant pressure (23.1 kPa) and fatty acids were identified by comparing the peaks with the mass spectral database.

Data were subjected to analysis of variance. Comparison of means was carried out by Duncan's multiple-range test. Analysis was performed using SPSS package (SPSS 10.0 for Windows, SPSS Inc, Chicago, IL, USA).

Proximate composition analysis revealed moisture, crude protein, crude fat and ash content to be 19.00±0.70, 48.29±0.64, 3.62±0.09 and 16.05±0.52% respectively (Table 1). Presence of high moisture content indicated improper drying of *Acetes*. It is recommended to have less than 10% moisture for a good quality dried products with extended shelf life. Zynudheen *et al.* (2004) reported moisture content of 10% in *Acetes* dried under controlled conditions. It can be seen from the results that protein content of sun-dried *Acetes* was higher (48.29±0.64%) along with ash (16.05±0.52) and fat (3.62±0.09) indicating its nutritive potential as a food.

Biopolymer content in terms of chitin was found to be 10% in dried *Acetes*. Chitin is the most abundant natural

Table 1. Proximate composition of sun-dried *Acetes*

Constituents	Values on wet basis (g 100 g ⁻¹)
Moisture	19.00±0.70
Crude protein	48.29±0.64
Crude fat	3.62±0.09
Ash content	16.05±0.52
Chitin	10.00±0.67

polysaccharide on earth next to cellulose. It acts as protective and supporting compound with several other health benefits. The large sized shrimps are usually consumed after removal of their shell, but *Acetes* being very small is usually consumed whole thereby helping in intake of this health beneficial chitin by the consumers. The average head and shell waste yield from the shrimp is around 60% by weight of the whole shrimp (Pal *et al.*, 2014). Zynudheen *et al.* (2004) reported chitin content of dried *Acetes* to be $13.00 \pm 0.67\%$. But in case of prawn waste, its content is around 15-20% (Gopakumar, 2002). Results of the present study indicated that the chitin content in dried *Acetes* was slightly less than that reported earlier.

Amino acid profile of traditionally sun-dried *Acetes* obtained by acid derivitisation following HPLC analysis are given in Table 2. From the results, it can be seen that amino acids such as glutamine, alanine and aspartic acid to be more with 294.07, 160.55 and 134.97 per 1000 residues, respectively in traditionally sun-dried *Acetes*. Essential amino acids like leucine, lysine and sulphur containing amino acids are also present in good amount *i.e.*, 90.41, 53.66 and 54.85 per 1000 residues, respectively. From these results, it can be confirmed that, in terms of both quantity and quality, *Acetes* can serve as an important source of essential amino acids and that the sulphur-containing essential amino acids and lysine present in *Acetes* can supplement the corresponding deficiencies in plant proteins. Eight essential and five non-essential amino acids including glutamine, asparagine, lysine, leucine, arginine, glycine and valine were recorded in abundant qualities in the caridean prawn *Macrobrachium vollenhoveni* from Ovia River and tropical periwinkle *Tympanotonus fuscatus* (Ehigiator and Oterai, 2012). Vazquez-Ortiz *et al.* (1995) reported, free amino acid contents of glycine, alanine

Table 2. Amino acid profile of sun-dried *Acetes*

Amino acids	(per 1000 residues)
Aspartic acid	134.97
Theronine	23.40
Serine	32.98
Glutamine	294.07
Proline	13.93
Glycine	19.31
Alanine	160.55
Valine	35.40
Methionine	12.12
Isoleucine	22.94
Leucine	90.41
Tyrosine	12.05
Phenylalanine	18.20
Histidine	54.85
Lysine	53.66
Arginine	30.79

and proline to be higher than those of other amino acids in wild and cultured shrimp species *Penaeus vannamei*.

Fatty acid profile by GCMS revealed EPA (13.11%) and DHA (8.19%) as the major fatty acids in *Acetes*. From these results, it can be concluded that dried *Acetes* can be a good source of health beneficial omega-3 fatty acids, *i.e.*, DHA and EPA (Table 3). The principal fatty acids in the marine shrimps, *Penaeus brasiliensis*, *Penaeus schimitti* and *Xiphopenaeus kroyeri* were, reported as C16:0, C20:5 n-3, C22:6 n-3, C18:1 n-9, C18:0, 16:1 n-7, 20:4 n-6 and 18:1 n-7 and in the freshwater prawn *Macrobrachium rosenbergii*, the major fatty acids found were, C16:0, C20:5 n-3, C18:1 n-9, C18:0, C22:6 n-3, C18:2 n-6, C17:0 and C18:1 n-7 (Bragagnolo and Rodriguez-Amaya, 2001). Fatty acid profile of dried *Acetes* indicated the presence of most of the fatty acids reported earlier.

Table 3. Fatty acid profile of sun-dried *Acetes*

Fatty acids	Formula	% of total fatty acids
Methyl tetradecanoate	C14:0	5.56
Pentadecanoic acid	C15:0	0.92
Hexadecanoic acid	C16:0	32.15
9- Hexadecenoic acid	C16:1 (n-7)	14.95
Heptadecanoic acid	C17:0	1.82
Octadecanoic acid	C18:0	7.35
9-Octadecenoic acid	C18:1 (n-9)	7.82
9, 12- Octadecadienoic acid	C18:2 (n-6)	1.56
9,12,15-Octadecatrienoic acid	C18:3 (n-3)	0.98
Eicosanoic acid	C20:0	0.40
11- Eicosenoic acid	C20:1 (n-9)	0.31
5, 8, 11, 14- Eicosatetraenoic acid	C20:4 (n-6)	4.87
5, 8, 11, 14, 17 Eicosapentanoic acid	C20:5 (n-3)	13.11
4, 7, 10, 13, 16, 19-Docosahexaenoic acid	C22:6 (n-3)	8.19

Mineral profiling (Table 4) showed that traditionally sun-dried *Acetes* contains P, Ca, K, Mg, Na and Fe. Among these minerals, Ca and Na were found in higher proportions, *i.e.* 4.553 and 3.016% respectively. Sriket *et al.* (2007) reported that black tiger shrimp meat had higher contents of minerals than white shrimp meat and Mg was the dominant mineral in the meat of both the shrimps, followed by Ca and Fe at high levels. Ca is essential for hard tissue structure, blood clotting, muscle contraction, nerve transmission, osmoregulation and as a cofactor for enzymatic procession (Lovell, 1989). In the present study, *Acetes* showed dominancy of Ca than other minerals.

Heavy metal analysis (Table 5) revealed the presence of cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn) at

Table 4. Mineral content of sun-dried *Acetes*

Minerals	Quantity (g 100 g ⁻¹ sample)
P	0.030
Ca	4.553
K	0.980
Mg	0.924
Na	3.016
Fe	0.023

Table 5. Heavy metal content of sun-dried *Acetes*

Heavy metals	Quantity (ppm)
Cd	1.42
Cu	39.51
Pb	0.47
Zn	46.48

1.42, 39.51, 0.47 and 46.48 ppm concentration, respectively. Heavy metal concentration in tissues of shrimp and fish depends upon the food chain or link of food chain. Therefore, these organisms are good indicators of metal accumulation in marine environment. The high concentration of zinc found in the dried *Acetes* in the present study is indicative of the greater extent of pollution of the water from which it was caught.

Results of microbial analyses showed total plate count (TPC) in dried *Acetes* as 4.1×10^3 cfu g⁻¹. Faecal coliforms determined by MPN method was 35 MPN 100 ml⁻¹. Colonies of *S. aureus* were not detected. From these results, it can be concluded that the dried *Acetes* was not processed hygienically as reflected by the presence of higher number of faecal coliforms. However, proximate composition, amino acids, fatty acids and mineral profiles of dried *Acetes* indicate that it can be a good source of health beneficial nutrients.

Acknowledgements

The authors would like to express their sincere thanks to Dr W. S. Lakra, former Director, ICAR-CIFE, Mumbai for the facilities provided to carry out the work.

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Date of Receipt : 28.01.2017

Date of Acceptance : 30.06.2017

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