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Short Communication

Potential use of mud clam (*Geloina coaxans*) in producing sauce with papaya crude extraction as a protein hydrolysing agent

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Abstract
Mud clam (*Geloina coaxans*) are underutilised food source due to the lack of consumer preference in Sri Lanka. Hence, this study was conducted to produce clam sauce as a value added product using the muscle of mud clams by means of accelerated fermentation method. Specimens were collected from Tambalagam Bay, Sri Lanka. Shell length, height, inflation, total weight with shell and without shell were 6.3 ± 0.4 cm, 5.3 ± 0.3 cm, 3.5 ± 0.3 cm, 83.1 ± 13.4 g and 14.9 ± 1.3 g respectively. The extracted mean meat yield was 14.9 ± 1.3% per mud clam. Moisture, crude protein, crude lipid and ash (dry weight) content of raw meat were 80.45 ± 0.89%, 64.14 ± 0.96%, 3.55 ± 0.39% and 7.54 ± 0.61% respectively. Final sauce product shows liquid yield, energy value, ^{0}Brix value, pH, % NaCl, total nitrogen, moisture and ash content as 98.3 ± 5.5 ml 100g^{-1}, 2124 ± 133 J g^{-1}, 24.3 ± 0.9%, 5.02 ± 0.04, 14.53 ± 0.27%, 0.27 ± 0.01%, 74.06 ± 0.56% and 19.66 ± 1.99% respectively. The study concluded that the mud clam meat is a possible candidate as a raw material for the production of clam sauce.

Keywords: Accelerated fermentation; clam sauce; *Geloina coaxans*

1 | INTRODUCTION

Bivalve exploitation and cultivation for food, ornamentation and pearls are worldwide practices for decades and farming for food is a multi-billion-dollar industry worldwide (Wijsman *et al.* 2019). Despite the abundance of edible bivalve species in most of the coastal zones of Sri Lanka (Chinivasagam 1989) value addition of bivalves is not much popular (Silva *et al.* 2013). Edible bivalves such as *Marcia hiantina*, *M. opima*, *Gafrarium tumidum* and *Meretrix casta* are commonly found in Puttalam Lagoon and Dutch Canal in the west coast of Sri Lanka (Kithsiri *et al.* 2004; Jayawikrema and Wijeyaratne 2009). Furthermore, diverse edible clams, mussels and oyster species are also abundant in the Tambalagam Bay in Trincomalee district along the east coast of Sri Lanka (Nafees *et al.* 2009). The mud clam *Geloina coaxans* is the most common bivalve species in Tambalagam Bay area.

Bivalves are a good source of protein, vitamins (e.g. vitamin C and Vitamin B_{12}) and minerals (e.g. iron, manganese, phosphorus, selenium and zinc) and fatty acids for humans (Shanmugam *et al.* 2007; Patrick 2012). Despite the fact that it is a luxury food item in many foreign

countries, it is not much popular among Sri Lankans (Silva *et al.* 2013). Hence, local consumption could be increased by encouraging people through promoting and marketing it as a value added product. Sauce is one of the value added products, which is produced by using different kind of raw materials such as fish (marine and freshwater) and oysters, chilly, tomato and soybean. In many South East Asian countries, fish is mixed with salt and keep for one to two years for fermentation to produce their traditional fish sauce (Hariono *et al.* 2005). However, enzymes can be used as a protein hydrolysing agent to speed up the fermentation process. Papain is a very effective protein hydrolysing enzyme that can be extracted from papaya (*Carica papaya*) latex, unripe fruit, leaves and roots (Hitesh *et al.* 2012). The present study was carried out to investigate the possibility of using papaya crude extract as a source of papain enzyme to hydrolyse the protein in mud clam muscle to produce clam sauce through accelerated fermentation method.

2 | METHODOLOGY

One hundred mud clams (*G. coaxans*) were purchased from a fisherman in Tambalagam Bay, Kinniya, Sri Lanka. Biometric parameters (shell height, length, inflation and weight of the whole animal with the shell) were measured for each individual. Afterwards, shell of each bivalve was removed and weight of the muscle was recorded.

Separated muscle parts of the clam individuals were immediately sealed in polythene bags and kept in a polystyrene box with ice to retain freshness during the transportation to the laboratory of the Department of Animal Science, University of Peradeniya. Soon after the arrival, proximate composition of raw muscle was analysed by means of standard methods (AOAC 1995). Bivalve sauce was prepared according to the method described by Chuapoehuk and Raksakulathai (1992), with some modifications in which unripe papaya crude extraction was used as a Protein hydrolysing agent. Hush and seeds of unripe papaya fruit were removed and the fruit was cut into small pieces, which were ground into a pulp. The papaya pulp was filtered through a linen cloth to separate papaya crude extract and kept it inside a refrigerator in a lid closed glass bottle. Cleaned, frozen clam muscles were sliced and ground to make a pulp. For the fermentation process 100 g of mud clam muscle pulp, 40 g of table salt (NaCl) and 60 g of papaya crude extract were mixed thoroughly in a glass bottle. Then, the bottle was closed with a para film and sealed properly and kept it at 60°C in an oven for 10 days until fermentation. After 10 days, the mixture was filtered through a Whatman No. 4 filter paper into a glass bottle and a dark brownish colour filtrate was obtained as the clam sauce. The volume of the filtrate was measured and liquid yield of the clam sauce was determined. Then, the prepared sauce was subjected to analyse for proximate composition, pH, salt content (Volhard method), ^{0}Brix value and energy value (Chuapoehuk and Raksakulathai 1992; AOAC 1995; Hariono *et al.* 2005; Muangthai *et al.* 2009).

3 | RESULT AND DISCUSSION

The biometric measurements and percentage of total yield of mud clam which were harvested from Tambalagam Bay, Kinniya, Sri Lanka are presented in Table 1. Percentage mean total yield of the mud clam was 18.1 ± 1.8%. *Geloina coaxans* has a thick and heavy shell and thus, the weight of flesh obtained from mud clam is very low when compared to its total weight.

TABLE 1 Biometric parameters of *Geloina coaxans* (*n* = 100).

Biometric parameters	Mean (±SD)	Range
Shell length (cm)	6.3 ± 0.4	5.6 – 7.2
Shell height (cm)	5.3 ± 0.3	4.7 – 6.1
Shell inflation (cm)	3.5 ± 0.3	3.0 – 4.3
Total weight (with shell) (g)	83.1 ± 13.4	50.0 – 120.2
Weight (without shell) (g)	14.9 ± 1.3	12.4 – 17.5
Total yield (%)	18.1 ± 1.8	13.7 – 22.7

Proximate composition of *G. coaxans* muscle is shown in Table 2. Asha *et al.* (2014) reported that the crude protein and crude lipid content in muscles of *Crassostrea madrasensis*, a common bivalve species use in commercial oyster sauce industry, as 9.41 ± 0.85% and 3.25 ± 0.32% (wet weight basis) respectively. In the present study, *G. coaxan* contains higher amount of protein (12.62%) and lower amount of lipid (0.69%) when compared to *C. madrasensis*. Therefore, mud clam can be used as a low lipid and high protein source for human consumption.

TABLE 2 Proximate composition of *Geloina coaxans* (mean ± SD, *n* = 3).

Proximate composition	Dry weight basis (%)	Wet weight basis (%)
Moisture	–	80.45 ± 0.89
Crude protein	64.14 ± 0.96	12.62 ± 0.19
Crude lipid	3.55 ± 0.39	0.69 ± 0.08
Ash	7.54 ± 0.61	1.47 ± 0.12

Geloina coaxans is a low-priced and commonly available bivalve in the Tambalagam Bay. Therefore, it was used as the raw material to investigate the potential of production of clam sauce by means of accelerated fermentation method in this study. Papaya crude extract was used as an inexpensive locally available raw material to hydrolyse the protein in bivalve muscles during the fermentation process. Papaya crude extract contains cysteine protease, also known as papain or papaya proteinase which has the ability to hydrolyse the protein into amino acids (Hitesh *et al.* 2012). Accelerated fermenta-

tion process with papaya crude extract resulted in 98.3 ml $100g^{-1}$ of liquid yield of clam sauce (Table 3). However, Hariono *et al.* (2005) have extracted only 45 ml of fish sauce from 100 g of round scad (*Decapterus macrosoma*) and hard tail (*Megalaspis cordyla*) fish meats. Hence, considerably higher amount of liquid yield was produced in this study when compare with the previous studies.

The total soluble solid content (^{0}Brix) value depends on the amount of free amino acids and small peptides in the sauce (Hariono *et al.* 2005) which was 24.3% for *G. coaxans*. However, this value is 41.5% for commercial fish sauce (Hariono *et al.* 2005) which is higher than the ^{0}Brix value of clam sauce produced in this study. This was also the case for total-N content in the mud clam sauce in the present study (0.27%; Table 3) whereas the commercial fish sauce comprises 1.95% (Hariono *et al.* 2005). However, commercial sauces are usually mixed with different additives to enhance the flavour, texture and nutritional values. Especially monosodium glutamate (MSG) is used as a chemical additive to enhance flavour and it is a sodium salt of the naturally occurring non-essential amino acids (Kingsley *et al.* 2013). As a result, commercial products show high values of ^{0}Brix and total-N than the clam sauce produced in the present study which may be due to no use of any preservatives or additives in the present study.

TABLE 3 Liquid yield, energy content, ^{0}Brix value, chemical and proximate composition (wet weight basis) of the sauce produced from *Geloina coaxans* (mean ± SD, *n* = 3).

Properties	This study	Commercial fish sauce
Liquid yield (ml $100g^{-1}$)	98.3 ± 5.5	–
Energy value (J g^{-1})	2124 ± 133	–
Brix (%)	24.3 ± 0.9	41.5 (Hariono *et al.* 2005)
pH	5.02 ± 0.04	5 – 6 (Puat *et al.* 2015)
NaCl (%)	14.53 ± 0.27	19 – 20 (Puat *et al.* 2015)
Total N (%)	0.27 ± 0.01	>2.0 (Puat *et al.* 2015)
Moisture (%)	74.06 ± 0.56	–
Ash (%)	19.66 ± 1.99	–

Prepared clam sauce was slightly acidic with pH of 5.02±0.09 which roughly indicates the adequacy of fermentation (Hariono *et al.* 2005). However, the pH value of present experiment was laid on the acceptable pH range (5 – 6) which is described in Thai industrial standard for fish sauce (Puat *et al.* 2015). The salt content of mud clam sauce was 14.53%; slightly similar result was obtained for oyster sauce (Chuapoehuk and Raksakulthai 1992) in which 14.6% and 13.5% of salt contents were recorded when papain and bromelain were used to produce the sauce. Salt content is important in sauce production as it can prevent the spoilage during the fermentation of product (Shiau and Chai 1999).

Present study revealed that *G. coaxans* is a possible candidate to produce clam sauce by means of accelerated fermentation method with papaya crude extract as the protein hydrolysing agent. Moreover, this method can be used as a low cost method to prepare mud calm sauce and further research is needed to develop this method which can be easily used by local fishermen to prepare sauce as a value addition product of mud clam.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION
HMSM conceptualisation, data collection, data analysis and original manuscript preparation; KR supervision, manuscript review and editing; HWC supervision.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author.

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