

Review Article

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Status of Valuable Components from Pangasius: A Review

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ABSTRACT

Pangasius catfish is one of the world's fastest growing fresh water species in aquaculture. Different research findings have revealed development of various value added products from pangasius having global acceptance and commercial potential. The industry has expanded in terms of production and trade. Basa is being the preferred imported variety of Pangasius. It is now traded to well over 100 countries worldwide due to its mild flavor, whiter meat color and flaky cooked texture. The fish farmers practicing aquaculture have reported reduced profit margin. Also there is a great scope to increase the fish consumption by developing different varieties of innovative value added ready-to-eat, ready-to-cook, ready-to-sever 'convenience' fish products, demand for which has increased due to social and cultural changes in recent years. The waste material from Pangasius fish especially skin and bones on proper processing is considered as cheap source of valuable material having several food applications. This paper highlights the different types of value added food products prepared from Pangasius fish.

Keywords

Pangasius, Value addition and Waste utilization

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Introduction

Pangasius is a type of catfish that is endemic to the waters of Mekong basin in south-east Asia, belongs to the family Pangasiidae. This fish species is also known as *Pangasianodon hypophthalmus*, Sutchi catfish, striped catfish or Tra fish (Guimarães *et al.*, 2015). Pangasius catfish is one of world's fastest growing fresh water species in aquaculture (Jeyakumari *et*

al., 2016). Pangasius is now traded to well over 100 countries worldwide as skinless and bone less fillets popularly along with portions, steaks, fillets and its added value products (Thi *et al.*, 2013). The industry has expanded in terms of both production and trade.

The Pangasius attains body weight of 1.2 to 1.3kg rapidly within a short span of 6 months but usually harvested after 8 months

depending on marketability (Gurung *et al.*, 2016). It is characterised by tender and white flesh, absence of fishy odour, firm cooked texture and high nutritive value with excellent sensory attributes has expanded consumer preference for Pangasius (Rao *et al.*, 2013).

High market demand and soared product prices for different Pangasius species reflect consumer preferences, Basa is the preferred imported variety of Pangasius, while the farmers undertaking Pangasius culturing have reduced profit margins.

There is great scope to increase the consumption by developing different value added products from Pangasius due to a mild flavor, white flesh color, firm cooked texture, low fat content (Orban *et al.*, 2008), easily digestible protein (Thammapat *et al.*, 2010) and nutritional properties beneficial for human health (Usyus *et al.*, 2011).

There is great demand for fish based products especially value added products, ready-to-eat 'convenience' products (Rathod and Pagarkar, 2013) due to recent social and cultural change. Filleting industry produces significant amounts of head, bone, scrap meat and skin by-products (Thuy *et al.*, 2010) which on proper processing can be converted to various high value products having good economic efficiency. Fish processing waste is good potential source of gelatin and more than 30% fish weight comes from skin and bones. Also, utilization of waste as a source of potential value added products can reduce waste (Atma, 2017).

Global status of pangasius

Global aquaculture production of pangasius was 419387 tons (FAO, 2015). In Vietnam, Pangasius is mainly processed for export market, in 2008 alone export of Pangasius surpassed rice, coffee and shrimps while in

2012 export to Europe alone was around 143,200 tons. Italy annually imports approximately 12,780 tons (Dambrosio *et al.*, 2016).

Value addition

Adding value means employing processing methods, specialized ingredients or novel packaging to enhance the nutrition, sensory characteristics, shelf life and convenience of food products.

Now-a-days, development of low cost, high energy and nutrient rich food is a constant challenge in developing countries (Pagarkar *et al.*, 2011). As per the changing demand of the consumer while developing new meat products or upgrading the existing following factor should be consider.

Developed from the naturally occurring raw materials.

Consumed as a part of daily life and have good acceptability.

Subjected to minimum processing or no additives or less additives.

Economical.

Should be easy to handle, preserve, store and prepare.

Minimum impact to the environment.

The fish and fish products are considered as the most healthy food component of the human diet. Therefore, demand for fish products has increased in national and international markets.

Studies on different types of value added products developed from Pangasius fish are detailed below:

Pangasius fillet

Pangasius fillets are affordable substitute for white fleshed fishes in the western market with ever increasing acceptability and popularity, usually Pangasius is served to the European market as skinned and boneless frozen fillets (Nosedá *et al.*, 2012), currently been exported to over 100 countries worldwide (Guimarães *et al.*, 2015), popularly known as 'Basa' (Rao *et al.*, 2013) accordingly development of value added fillet also support the growth in production (Ramadhan *et al.*, 2016).

Pangasius fillets are value added product made by separating meat from thorns, skins and other unwanted material which is then frozen stored. Fillets are advantageous as they are easily processed and consumed food materials as a whole. They also require very less storage space due to their flat shape, which makes them easy to stack (Ramadhan *et al.*, 2016). Preparing and marketing value added fillets from Pangasius fish is more economical and easy (Rao *et al.*, 2013).

Orban *et al.*, (2008) studied the new trends in the seafood market, nutritional quality and safety aspects of frozen and thawed fillets of (*P. hypophthalmus*) in the Italian market. Proximate composition, mineral content, fatty acid profile, unsaponifiable components of the lipid fraction and drip loss during thawing at 5°C were determined on the fillets. Fillets were characterised by high moisture levels 80% and low crude protein 15.6% and lipid 3.0% contents. Total lipids were characterised by low cholesterol levels 39 mg/100 g, high percentages of saturated fatty acids 47.8% of total fatty acid and low percentages of polyunsaturated fatty acids 18.8% of total fatty acids, which were mainly represented by linoleic acid 59% of total polyunsaturated fatty acids. The mineral composition was characterised by a high sodium content 594

mg/100g, probably partially due to the sodium tripolyphosphate used to retain moisture. As regards safety aspects, the quality of the samples analysed was good, with low residue levels of mercury, organochlorine pesticides and polychlorinated biphenyls.

Domiszewski *et al.*, (2011) assessed Pangasius fillets one year before expiration date for effect of different heat treatment on quality of lipids via gas chromatography. Results showed conventional cooking and microwave cooking had no change on saturated fatty acids (SFA) and mono unsaturated fatty acids (MUFA) while 10% change in Poly unsaturated fatty acid (PUFA) including Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA). EPA and DHA were reported to be 16.5, 12, 22, 23 mg in raw, conventional cooked, microwave cooked and frying cooked fillets. Heat treatment helped maintaining lipid quality all samples had peroxide value (PV) below 3 meq O₂/kg lipids and Anisidine value below 1.5. Addition of salt during boiling increased peroxides 16 times and secondary oxidation products 4 times. Suggesting Pangasius as alternative to prok.

Nosedá *et al.*, (2012) microbial spoilage of vacuum and modified atmosphere packaged Vietnamese *P. hypophthalmus* fillets were studied. Moreover, they examined the growth and metabolite production of micro-organisms causing spoilage in air, vacuum and modified atmospheres (MAP) (MAP 1- 50% CO₂; 50% N₂ and MAP 2- 50% CO₂; 50% O₂) of *P. hypophthalmus* fillets during storage at 4^o C. Their result showed that use of CO₂ in modified atmosphere packaged Pangasius fillets significantly prolonged the shelf life compared to air and vacuum packaged fillets. Also found out that ethanol, 2,3-butanediol, diacetyl, acetoin, ethyl acetate, acetic acid and sulphur compounds like hydrogen sulfide, methylmercaptan, carbon disulphide and

dimethyl disulphide were the major spoilage related compounds in packed Pangasius fillets.

Rao *et al.*, (2013) investigated the effect of vacuum and polyphosphate on Pangasius fillets during chill storage. They concluded that chilled stored (<4 °C) Pangasius fillets using ice provide a minimum shelf life of 9 days. Whereas, fillets treated with 2% STPP and 1% NaCl proved to be beneficial as it increased moisture retention, lowered bacterial and delayed biochemical spoilage with improved textural quality.

Recently, Guimarães *et al.*, (2015) evaluated the chemical quality parameters regarding frozen *P. hypophthalmus* fillets from Vietnam. The authors reported presence of mercury (Hg) and malondialdehyde (MDA) hazardous compounds in more than 50% of studied samples along with detrimental compounds. Suggested the need for quality control points in production chain to promote product standardization for safer food supply chain.

Ikasari and Suryaningrum (2015) assessed the quality changes in Pangasius fillets during ice storage filleted by various methods. Findings reported methods of filleting did not significantly influence the quality during storage all samples were not acceptable after storage for 18 days.

Viji *et al.*, (2015a) studied the effects of turmeric treatment and smoking on the shelf life of ready-to-cook fillets from Pangasius catfish during chill storage and the results showed that turmeric treatment and smoking has a positive effect in controlling the quality changes associated with storage of the ready-to-cook smoked fillets.

Steaks/Chunks

Fish steak being a ready-to-cook value added product, acceptable in both domestic and

international markets (Lakshman *et al.*, 2015). Mohan *et al.*, (2008) assessed the effectiveness of O₂ scavenger on shelf life of Pangasius catfish steaks during chilled storage. Results showed that O₂ scavenger reduced the oxygen content by 99.58% within 24h in packages. O₂ scavenger packaged steaks maintained chemical (pH, TVB-N, TMA-N, TBA and PV), physical (drip loss and water holding capacity), microbial (total mesophilic and psychrotrophic counts), sensory qualities and lipid oxidation was reduced significantly, which extended the shelf life of steaks upto 20 days in comparison to air pack which had half the life 10 days.

Viji *et al.*, (2014) evaluated the shelf life of Pangasius steaks during iced and chilled storage accordingly sensory analysis reported that iced steak had additional shelf life of 3 more days i.e., 14 days in comparison of 17 days in ice stored, biochemical quality indices pH, TVBN, TBA and PV were within acceptable limits in both storages throughout the period. Total mesophilic count and Enterobacter counts were lower in ice stored in comparison to chill stored, while the chill stored steaks showed higher textural deterioration on comparison with ice stored steaks.

Kumari *et al.*, (2016) developed Pangasius steaks by *sous-vide* technology with its process optimization. Results suggested suitable combination of chitosan and spices which enhanced antimicrobial and oxidative stability. Chitosan concentration of 1.08%, temperature of 70.93⁰ C and cooking time of 16.48 min as optimised conditions for *sous-vide* processing of Pangasius steaks

Recently, Kumar *et al.*, (2017) analysed the suitability of Pangasius steaks for development of fermented product during its storage in PVC jar. Results confirmed development of characteristic flavour,

firmness and taste over the period of 135 days of study. During which moisture, ash, salt and free α -amino nitrogen (FAN) increased, thiobarbitric acid reactive substances (TBARS) showed a rising trend till 75 days and decreased continuously till maturity. Finally, fully fermented product had 56.67 %, 5.93, 18.17%, 14.43%, 0.21 mg/kg and 92.86mg/100gm of moisture, pH, ash, salt, TBARS and FAN respectively.

Jeyakumari *et al.*, (2017) studied the effect of spice extract (ginger, mint and green chilli) on biochemical, textural and sensory characteristics of chunks from Pangasius fish while the results suggested that 20% spice extract with ginger and mint can be used effectively as dip treatment to improve the sensory attributes, delay chemical deterioration and extend the shelf life of chunks. Sensory evaluation revealed that chunks had shelf life of 15, 12 and 9 days for treatment with ginger, mint and chilli extract during study; also concluded that chunks treated with ginger and chilli extract had improved textural properties over mint treatment (Table 1).

Meat/Mince

Pangasius fish, has become an economical valuable freshwater fishery product (Noseda *et al.*, 2012). Consumer preferences for Pangasius have increased due to its tender flesh, absence of fishy odour along with firm texture when cooked and high nutritive value with excellent sensory properties (Rao *et al.*, 2013) which forms the base material for development of various value added products.

Recently, due to increase in production of Pangasius species the profits has been lowered for producers. Development of different value added products from the fish with higher margin can be considered as an alternative to increase the profit (Viji *et al.*, 2015 a).

Viji *et al.*, (2015 b) studied the proximate composition of fresh Sutchi catfish (*P. hypophthalmus*) meat, found that it contains 17.63 ± 0.33 % protein, which indicates that the fish can be considered as a good table fish.

Fat content was found to be 2.12 ± 0.26 % which relates to its delicious taste, whereas moisture and ash content of the fish were 77.43 ± 1.46 % and 1.07 ± 0.12 %, respectively.

Hassan *et al.*, (2016) studied the effects of cryoprotectants (4% sucrose, and 4% sorbitol with 0.2% STPP) on Pangasius mince during refrigerated storage. Results from biochemical analysis (NPN, FFA, PV, TVBN and TBARS), proximate changes, pH, textural, SDS PAGE and sensory analysis concluded that cryoprotectants had no effect on quality improvement on Pangasius mince and had a shelf life of 3 days during refrigerated storage.

Surimi

Surimi is the Japanese term for concentrated myofibrillar protein which is defined as mechanically de-boned, washed and cryostabilized fish paste that is used for the production of seafood analogues and other new products (Jeyakumari *et al.*, 2016). It is frozen and stored in block form. Surimi is the raw material for gel based snack foods such as kamaboko (Desai *et al.*, 2007; Thorat *et al.*, 2007) and fish balls (Balange *et al.*, 2004; Santana *et al.*, 2012; Kolekar *et al.*, 2013; Majumdar *et al.*, 2016). Pangasius is cultured on large scale in India and Bangladesh having a high growth rate so, the excess catch of striped catfish can be alternatively converted to surimi and used as base for making restructured products (Majumdar *et al.*, 2016).

Majumdar *et al.*, (2016) investigated the effect of natural spice extracts on textural and functional properties of surimi from striped catfish Pangasius.

Table.1 Different studies on development of products from Pangasius

Products	Study conducted	Reference
Gutted and whole fish	Reported the effects of gutting on shelf life of whole fish in comparison to ungutted fish during ice storage. Results indicated gutting improved the sensorial quality, microbial analysis determined shelf life of 16-18 days and 18-20 days for gutted and ungutted fish respectively, whereas pH didn't showed any significant changes in both cases, while gutted fish expressed higher rate of primary lipid oxidation than ungutted fish. Total volatile base nitrogen (TVB-N), alpha amino nitrogen (AAN), free fatty acids (FFA) and thiobarbituric acid reactive substance (TBARS) parameters lowered in gutted ones in comparison to un-gutted fish.	Viji <i>et al.</i> , (2015b)
Fillets	Studied nutritional qualities and safety aspects of Pangasius fillets produced in Vietnam, available on Italian market. Fillets were characterized by high moisture and low protein and lipid content. Total lipids consisted of low cholesterol levels, high percentages of saturated fatty acids and low percentages of polyunsaturated fatty acids. The quality of analysed samples was good with low residues of mercury, organochlorine pesticides and polychlorinated biphenyls.	Orban <i>et al.</i> , (2008)
	Assessed effects of different heat treatment on lipid quality of Pangasius. Results showed changes in PUFA including EPA and DHA by 10% and no change in SFA and MUFA on different heat treatments. Lipids maintained good quality after the treatment – PV of every sample was below 3 meq O ₂ /kg lipids and Anisdine Value below 1.5. Addition of salt during boiling increased peroxides 16- times and fourfold increase in the amount of secondary oxidation products.	Domiszewski <i>et al.</i> , (2011)
	Investigated the microbial spoilage of vacuum and MAP packaged Pangasius fillets. Based on results of microbial analysis shelf life of air packed fillets, vacuum, MAP1 (50% CO ₂ & 50% N ₂) and MAP2 (50% CO ₂ & 50% O ₂) were found to be 7, 10, 12 and 14 days respectively.	Noseda <i>et al.</i> , (2012)
	Studied the shelf life of Pangasius fillet with treatment of sodium tripolyphosphate (STPP) and vacuum during chilled storage, treated samples had shelf life of 9 days with improved texture and better moisture retention.	Rao <i>et al.</i> , (2013)
	Assessed the storability of Pangasius fillets, filleted by different methods under ice storage. Concluded with no significant effect of method of filleting on shelf life under ice storage all samples were unacceptable after 18 days.	Ikasari and Suryaningrum (2015)
	Evaluated effects of turmeric treatment and smoking on Pangasius fillets during chill storage. Results revealed that treatment with 2% turmeric and smoking at 60°C for 1h and 2h had shelf life of 14 and 21 days respectively on storage at 4°C on comparison the respective control samples had 7 and 17 days respectively.	Viji <i>et al.</i> , (2015a)
	Studied effects of different frozen techniques on chemical and microbiological qualities of Pangasius fillets. Results revealed presence of microbes but, within range prescribed by International commission on microbiological specification for foods (ICMSF) also the chemical (six metal indicator) quality were below safety levels for human consumption.	Dambrosio <i>et al.</i> , (2016)
Steaks/ Chunks	Assessed the scavenging effect of O ₂ scavengers on shelf life of chilled stored pangasius steaks. Results concluded that O ₂ scavengers effectively reduced the oxygen concentration by 99.58% in 24 h in packages, which had direct impact on shelf life which was doubled in comparison to air packs (10 days), by maintaining chemical, microbial and sensory attributes. Significant reduction in lipid oxidation was noted in steaks packed with O ₂ scavenger.	Mohan <i>et al.</i> , (2008)
	Studied the quality changes of Pangasius steaks in iced (0°C) and chill (4°C) storage. Results revealed biochemical quality parameters pH, total volatile base-	Viji <i>et al.</i> , (2014)

	Nitrogen (TVB-N), thiobarbituric acid (TBA) and peroxide value (PV) were in acceptable range during storages. Iced steaks showed lowered Total mesophilic and Enterobacter counts in comparison to chilled stored, on contrary the chilled stored steaks showed greater extent of deterioration in texture. Pangasius steaks stored in chilled and iced storage had shelf life of 14 and 17 days respectively based on sensory and microbiological analysis.	
	Developed Pangasius steaks by <i>sous-vide</i> with its process optimized. Results based on study suggested appropriate blend of chitosan and spices for enhanced antimicrobial and oxidative stability, while process optimization suggested 1.08% chitosan concentration, 70.93 ^o C as cooking temperature and 16.48 min for cooking time as optimum condition.	Kumari <i>et al.</i> , (2016)
	Suitability of Pangasius as raw material for salt fermented product during 135 days was analysed in PVC jar. Analysis confirmed that ash, salt and free α -amino nitrogen (FAN) showed a rising trend. Thiobarbituric acid reactive substance (TBRAS) content increased till 75 th day further and decreased till maturation which concluded that Pangasius developed the characteristic flavour and consistency over 135 days of maturation.	Kumar <i>et al.</i> , (2017)
	Studied antioxidant and total phenolic effects of different spice extract (ginger, mint and chilli) on Pangasius chunks during ice storage. Results indicated that mint extract had highest antioxidant and phenolic content in comparison to other two, while Pangasius fish chunks treated with 20% spice extract showed lower values of TVB-N, PV and TBA on comparison to control samples. Textural quality of chunks treated with ginger and chilli had improved over mint, sensory evaluation revealed that the samples had shelf life of 9, 12 and 15 days for control (untreated), chilli, mint and ginger treated samples respectively.	Jeyakumari <i>et al.</i> , (2017)
Fish fingers	Studied percentage of meat yield in different stages during dressing of Pangasius fish. They prepared fish fingers from Pangasius fish and battered with different types of battering materials.	Pagarkar <i>et al.</i> , (2017)
Mince	Evaluated suitability of Pangasius mince for production of restructured fish products with use of microbial transglutaminase (MTGase) along with sodium caseinate (1 %) and egg white (2 %) as protein substrate for MTGase by hot and cold setting. Results suggested use of protein substrates (sodium caseinate and egg white) in developing MTGase mediated restructured fish products, which imparted better binding characteristics. The results also proved the pro-oxidant effect of MTGase in both settings and possibility of converting Pangasius mince to value added restructured fish products.	Sarika <i>et al.</i> , (2013)
	Studied the effects of cryo-protectants on the keeping quality of mince from Pangasius in refrigerator. Results found that Pangasius mince mixed with cryo-protectants (4% sucrose and 4% sorbitol with 0.2% STPP) degraded quickly under refrigerated storage which was revealed by pH, proximate composition, biochemical, textural evaluation, SDS PAGE and sensory evaluation values. Results suggested Pangasius mince can be stored only for 3 days in refrigerator.	Hassan <i>et al.</i> , (2016)
Surimi	Analysed effect of garlic's aqueous extract (GAE) on restructured products from Pangasius surimi during refrigerated storage. Incorporation of GAE enhanced water holding capacity due to good protein network formation, while lower protein solubility suggested protein aggregation. Concentration of GAE had different effect on rate of lipid oxidation while gel strength improved by GAE incorporation. Sensory evaluation revealed restructured products with 1% GAE was most acceptable.	Majumdar <i>et al.</i> , (2016)
	Studied the quality changes of restructured products from Pangasius surimi incorporated with chitosan during chilled storage. Biochemical parameters (TVB-N, PV and TBA) showed a rising trend. Based on sensory and microbial analysis the developed product had shelf life of 17 days while control had 10 days.	Jeyakumari <i>et al.</i> , (2016)
	Developed the process to optimize the process of surimi preparation from	Hassan <i>et al.</i> ,

	Pangasius. Results indicated that surimi obtained from third and fourth washing cycles had highest gel strength, lowest expressible moisture similarly sensory evaluation rated highest overall acceptability to surimi obtained with third and fourth washing and concluded that three washing cycles with 1:3 (mince: water) ratio is optimum for making good quality surimi from Pangasius.	(2017)
Pickle	Value added product fish pickle from Pangasius fish was developed and stored at ambient conditions, results showed that Pangasius pickle could be stored upto 180 days; during the storage tenure PV and TVB-N showed a rising trend while pH showed a decreasing trend within acceptable range for 180 days.	Patil <i>et al.</i> , (2014)
Cutlet	Prepared cutlet from Pangasius meat and subjected to chemical, microbial and sensory analysis which showed it had shelf life of 16 days in refrigerated display unit. Results found that PV, Free Fatty Acid (FFA) and TVB-N were on higher side but within acceptable range, also no pathogenic organisms were detected during storage period.	Rathod <i>et al.</i> , (2013)
	Prepared cutlets from mince of Pangasius and studied the nutritional, texture and acceptability along with effect of processing method on quality of final product. Results reported that cutlets made from cooked mice were having less hardness and cutting strength; while having higher protein and fat content in comparison to raw mince. No significant difference was found for cutlets made from raw mice, cooked mince, with or without potato, batter and breadcrumbs.	Reddy (2016)
Patties	Influence of mushroom (<i>Agaricus bisporus</i>) on quality and storability of patties from Pangasius catfish. Results confirmed improvement in nutritional characters by incorporation of mushrooms, also the shelf life had increased by 4 days in patties treated by 15% button mushroom in refrigerated storage.	Nayak <i>et al.</i> , (2015)
Noodles	Developed noodles by incorporating green sea weed and Pangasius fish mince, results indicated use of green sea weed puree enhanced fibre content of noodles.	Debbarma <i>et al.</i> , (2017)
Sausages	Sausages were prepared from fresh Pangasius minced meat and its chemical, microbiological quality and textural properties were studied. The storage stability of the prepared sausages at ambient and refrigerant temperature was found to be 2 days and 35 days respectively.	Joshi (2012)
Gelatin	Extracted gelatin from Pangasius skin at 50°C for different time durations 6, 8, 10 and 12 hours, based on functional properties gelatin extracted at 12 hours had superior qualities suggesting culinary applications.	Ismail <i>et al.</i> , (2013)
	Extracted and studied the physical properties of gelatin from Pangasius fish in comparison to commercial (Bovine/Porcine) gelatin. Pangasius gelatin had gel strength (513.75 g), viscosity (3.88 cP), turbidity (73.21%), foaming properties (foam formation ability 1.13 and foam stability 0.71), emulsion stability (34.2 to 44.6%) and adhesiveness (-369.1 g.sec) of the fish skin gelatin were higher on comparison to bovine bone gelatin, on contrary color (L* 43.62, C* 3.66 and h° 45.28), cohesiveness (0.838), gel elasticity, gelling and melting points of the fish skin gelatin (16.40 °C and 26.87°C, respectively) were lower than those of the bovine bone gelatin.	Trakul and Patcharin (2013)
	Optimized the process of extraction of gelatin from Pangasius skin. Results suggested pre-treatment of 0.2 N NaOH and 0.1 N acetic acid, with hot water extraction at 63.7°C for 2.41 h which had high gel strength (438 g) and high content of amino acid (proline and hydroxyproline) (18.01%) with a viscosity of 4.67 mPas. Also suggested gelatin from Pangasius also had higher quality of physicochemical properties than those from bovine skin gelatin.	Mahmoodani <i>et al.</i> , (2014b)
	Extracted gelatin from Pangasius skin by action of bleaching with H ₂ O ₂ treatment. Results showed an increase in gelatin extraction from skin by action of bleaching agent with improved properties.	Sing and Benjakul (2017)

Table.2 Proximate compositions of different products from different studies

Parameters	Products								
	Pangasius skin	Pangasius skin gelatin	Pangasius fish bone gelatin	Pangasius mince	Pangasius meat	Pangasius Surimi	Pangasius fillet	Pangasius Pickle*	Battered and breaded Pangasius cutlet
Water	60.86	7.05	9.2	74.79	77.43	75.82	84.82	60.25	61.22
Protein	35.83	91.33	87.3	18.85	17.6	16.91	12.51	14.38	17.53
Ash	0.18	1.38	2.6	1.36	1.07	0.95	0.77	5.45	12.05
Lipid	2.19	0.23	0.96	4.34	2.12	2.76	1.65	17.16	5.59
Reference	Trakul. And Patcharin (2013)	Mahamoodani <i>et al.</i> , (2014)	Atma (2017)	Hassan. <i>et al.</i> , (2017)	Viji <i>et al.</i> , (2015b)	Jeyakumari <i>et al.</i> , (2016)	Guimarães <i>et al.</i> , (2015)	Patil <i>et al.</i> , (2014)	Reddy (2016)

*Contains 2.76% Carbohydrates.

Reported that the surimi made from Pangasius fish had a positive effect on gelling and textural properties by addition of aqueous extract of garlic, clove and cinnamon, also the water holding capacity increased with increase in concentration of extracts, whereas whiteness of gel which is an important attribute showed a reverse trend.

The effect of chitosan on shelf life of restructured fish products from Pangasius (*P. hypophthalmus*) surimi during chilled storage were studied by Jeyakumari *et al.*, (2016). In which restructured products were prepared from Pangasius surimi by incorporation of chitosan subjected to qualities analysis under chilled storage and results from the study indicated that chitosan coating could be used as a natural ingredient to prevent lipid oxidation in surimi based food systems for the development of novel healthy fish products.

Recently, Hassan *et al.*, (2017) studied the effect of the different washing cycles on gel strength and whiteness, For this study Pangasius mince was subjected to different washing cycles (one, two, three and four times) in the ratio of 1:3 of mince to water.

They concluded that third and fourth wash gave highest gel strength and whiteness to surimi as compared to other washing treatments to Pangasius mince. The surimi yield was more in third washing as compared to fourth wash.

Pickle

High perishability of fish and fish products is a serious problem in tropical countries like India due to prevailing climatic conditions (Sahu *et al.*, 2012). Pickling is one of the traditional method of fish preservation in India, then too very few spiced and pickled products are prepared that to on a domestic scale (Chandrashekhar *et al.*, 1978; Patil *et al.*, 2014). Fish pickling in vinegar and edible oil with added salt, spices and condiments provide ready to eat highly acceptable convenience product with good self-stability at an ambient temperature (Sahu *et al.*, 2012).

Development of value added product fish pickle from Pangasius fish and subjected to storage at ambient conditions to determine shelf life by analysing biochemical and organoleptic changes. The study found that

based on biochemical and organoleptic evaluation the Pangasius pickle prepared using standard recipe was acceptable for 180 days. During storage the organoleptic acceptability increasing trend till 150 days, afterwards it shows declined trend, biochemical analysis (pH, PV and TVB-N) showed the product was in acceptable condition for 180 days at ambient conditions (Patil *et al.*, 2014).

Battered and breaded product

Battering and breading is employed for value addition, which forms a main segment in ready meal market (Da and Nagalakshmi, 2014). Battered and breaded product is convenience food valued greatly by the consumers all over the world (Pawar *et al.*, 2012; Rathod *et al.*, 2013). The process of coating with batter and bread crumbs increases the bulk of the product, thereby reducing the content of costly fish and thus reducing the cost product. Coating enhances the appearance, colour, texture and taste of food products and also the nutritional value of the product (Rathod *et al.*, 2012).

Also, batter and breading develops unique flavours and textures in fried products. It provides tender and juicy interior foods and crispier crust outside (Da and Nagalakshmi, 2014). Coatings with different types of batters showed significant change in moisture retention and oil uptake with better sensory ratings (Pagarkar *et al.*, 2012).

Rathod and Pagarkar (2013) investigated the quality changes of fish cutlet made from Pangasius fish based on evaluation of biochemical parameters (pH, PV, FFA and TVB-N) and sensory qualities on storage in a refrigerated display unit (-15 to -18°C). The results suggested that the cutlet was in acceptable condition for 16 days during storage. The rate deterioration was

accelerated with the storage time. Biochemical parameters such as pH, peroxide value, free fatty acid and total volatile base-Nitrogen showed a rising trend during the period of study. Scores for sensory parameters viz., appearance, colour, taste, odour and overall acceptability showed a decreasing trend.

Nayak *et al.*, (2015) evaluated the influence of Button mushroom (*Agaricus bisporus*) on storability and quality of patties made from Pangasius fish on refrigerated storage. Biochemical and sensory qualities indicated incorporation of mushroom was acceptable till 16 days with improved nutritional quality while one without were acceptable for 12 days only.

Reddy (2016) prepared cutlets in eight different combinations from minced meat of Pangasius fish also studied their nutritional composition, texture profile, acceptability and effects of processing methods on quality of cutlets were also evaluated. In this study it is concluded that nutritional composition, textural quality and sensorial acceptability of Pangasius cutlets is not affected by different processing methods used. Also based on availability of materials, final product quality and economic viability any method can be used to make cutlet with good quality and sensorial acceptability (Table 2).

Gelatin

Gelatin is heterogeneous mixture of high molecular weight water soluble protein derived from collagen by heat denaturation. The production of gelatin all over the world is about 140,000-160,000 tons per year. Pangasius filleting industry produces large amount of skin and bones byproduct which are potential source of gelatin, which is high quality protein (Mahmoodani *et al.*, 2014a). Fish gelatin contains around 20% more

proline and hydroxyproline amino acids in comparison to bovine and porcine gelatins which contribute to higher melting point and gel strength (Mahmood *et al.*, 2016). Gelatin has a wide application in pharmaceutical, cosmetics along with food industries especially in body building foods (Atma, 2017). Gelatin from fish skin is more and more paid attention because of its special texture and “melt-in-mouth” property. Due to its characteristics of improving gelation, water binding, emulsifying, elastic and viscosity gelatin has wide applications (Atma, 2017).

Ismail *et al.*, (2013) extracted gelatin from Pangasius skin at different extraction time and evaluated its effects on functional properties. Results showed extraction at 50°C for 12 hours as most effective on comparison to 6, 8 and 10 hours, characterized by improved emulsifying capacity, emulsifying stability, water holding capacity, fat binding capacity, foaming capacity and foaming stability over other extraction times. Suggesting culinary applications to the quality gelatin extracted.

Trakul and Patcharin (2013) investigated optimal conditions for extraction of gelatin from Thai fish Pangasius (*Pangasius bocourti Sauvage*) skin. The results showed that the optimal condition for the extraction of gelatin from the skin of the Thai fish Pangasius was at 55°C for 1h at pH 4.55 which responded 20.22% yield, 506.55 g gel strength, 42.22 lightness (L*), 3.56 chroma (C*) and 43.35⁰ hue angle (h⁰).

Gelatin yield from Pangasius catfish skin was 23.61% (w/w) which is significantly higher when compared with gelatin from other fish species such as: black tilapia (5.4%), red tilapia (7.8%), bigeye snapper (4%), megrim (7.4%), sole (8.3%), cod (7.2%) and hake (6.5%). Also on comparison with bovine or porcine gelatin the gelatin extracted from

Pangasius fish possessed higher physicochemical properties (Mahamoodani *et al.*, 2014).

Atma (2017) evaluated proximate composition of fish bone gelatin from different warm water species and stated that fishbone gelatin from Pangasius catfish has the highest protein content as compared to commercially available gelatin also, based upon ash content in different warm water fish tested Pangasius fish bone gelatin alone met the standard of that commercial gelatin for application in food.

Sing and Benjakul (2017) extracted and characterized gelatin from Pangasius skin and studied its colour improvement. Results showed maximum yield 16.18g from skin bleached with 5% H₂O₂ for 48 hours, also bleaching improved emulsifying and foaming properties of gelatin by oxidizing the gelatin molecule.

It has been well documented that Pangasius fish has wide application in development of value added product. Preference is given to Pangasius especially because of its comparatively lower price, easy to eat, easy to cook, good taste and its high nutritive value. Comprehensive studies are needed for specific applications towards industrial exploitation and sustainability of the final products. This review is based on published literature summarizing the importance of Pangasius and different value addition that can be carried out.

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