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ORIGINAL ARTICLE

Nutritional, microbial and organoleptic qualities of fish patties prepared from carp (*Cyprinus carpio* Linn.) of three weight groups

Harjeet S. Sehgal · Meenakshi Shahi · Gurpreet K. Sehgal · Sukhcharan S. Thind

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Abstract Fish patty from common carp (*Cyprinus carpio* Linn.) which has low consumer preference due to the presence of intramuscular spines was developed and the effects of fish weight and the type of extender on product quality were determined. Six different types of fish patties were prepared by using the fish belonging to 3 weight groups (250–500 g, 501–750 g, and 751–1,000 g) and using 2 extenders (boiled potato and corn flour). Patties containing potato had higher moisture (70.6–73.3%), protein (31.5–32.7%) and lipid (3.3–4.6%) contents than those with corn flour (60–65.2, 27.8–33.3, 2.6–3.8%, respectively). Cooking decreased protein but increased lipid, soluble sugars, and gross energy contents of patties. Corn flour used patties gave higher cooking yield than those with boiled potato. These also had higher fat retention capacity and gross energy values. The 501–750 g group patties containing boiled potato had significantly higher scores for texture and overall acceptability.

Keywords Fish patty · *Cyprinus carpio* (Linn) · Weight groups · Extenders · Product quality

Freshwater fish production sector largely producing carps has received very little attention with respect to processing and value addition, although this sector has grown much faster than marine. Freshwater fish production of India increased from 0.89 million tons in 1980–81 to 3.3 million tons in 2005–06, which has been made possible through a phenomenal increase in aquaculture production, mainly of the Indian major carps and the Chinese carps (Ayyappan and Jana 2006). These carps having intramuscular bones have low consumer preference and hence limited market. Processing and value-addition to carps is a need to sustain carp culture, and to make it more profitable. Efforts to prepare value-added products from freshwater fishes such as surimi from silver carp (Yongkong et al. 2002), salad from *Labeo rohita* and *Catla catla* (Sehgal and Sehgal 2003), sausage (Sini 2003), and 'fish mince pakora' from *L. rohita* (Sehgal et al. 2010) have been reported. Karthikeyan et al. (2007) studied biochemical composition of seven dried freshwater fish products. In Punjab alone, there is a potential of consuming 32,448 tons per annum of such value-added products (Sehgal and Sehgal 2002). Fish patty is a convenience ready-to-cook product, which can be used in fish burger and is in good demand. Although data on patties prepared from marine fishes like Alaskan Pollock (*Theragra chalcogramma)* and/or Hoki (*Macruronus novaezelandiae)* are available (Anon 2010) those on freshwater fish are meagre. Recently, however, Sehgal et al. (2008) have reported the preparation of patties from *L. rohita*. This paper reports the potential of processing of low-value bony carp. (*Cyprinus carpio* Linn.) into fish patty.

Common carp (n=18) separated into 3 different weight groups *viz.* 250–500 g, 501–750 g, and 751–1,000 g were procured from the experimental fish farm, Ludhiana, transported live to the laboratory and quick-frozen at −25°C (Freezer model REMI 265 D BDI-229, capacity 265 litres, New Delhi, India). The time gap from procurement to freezing was 15–20 min. All the fish were procured on the same day. The frozen carp was thawed at 2°C for 15–18 h

H. S. Sehgal (✉) · M. Shahi · G. K. Sehgal
Department of Zoology, Punjab Agricultural University, Ludhiana 141 004, India
e-mail: drhssehgal@rediffmail.com

S. S. Thind
Department of Food Science and Technology, Punjab Agricultural University, Ludhiana 141 004, India

prior to being scaled, headed, gutted and rinsed. The fishes were then cut into 4–5 cm pieces, which were de-boned in a de-boning machine (Stadler Corporation, Mumbai, India) with a plate having 3 mm hole-size. The de-boned mince was freeze-stored at −20°C. Six different types of carp patties were prepared by using three weight groups of the fish (as mentioned above) and two extenders (boiled potato and corn flour). The product formulation consisted of 1,000 g fish meat mince, 90 g boiled potato or corn flour (extender), 30 g boiled soy flour (binder), 400 g onion, 100 g garlic, 28.4 g dried spice powder, 6.5 g dried unripe mango powder, 4.8 g monosodium glutamate and 12 g common salt (Sehgal et al. 2008). Fish meat mince was cooked at 195°C for 2 min on non-stick pan, mixed with other formulation ingredients, shaped into patty of 50–60 g each (6 cm diameter, 1 cm thick), each patty dipped in egg white batter, coated with bread crumbs, individually packed in LDPE (200 gauge) bag, quick frozen at −20°C (35–40 min) and stored for use. Patty was thawed at 5–10°C for 1 h and deep fat fried in refined sunflower oil at 180–185°C for 10 min (to golden brown colour).

Moisture was determined by gravimetric method and crude protein by total Nx6.25. Total N was estimated by the Kjeldahl's method (AOAC 2000). Total lipids and total soluble sugars were estimated by the methods of Folch et al. (1957) and Dubois et al. (1956), respectively. Gross energy was calculated on the basis of the numeric values of energy from crude protein, total lipids and total soluble sugars (Dujardin et al. 1983).

Cooking yield, fat retention capacity, and water holding capacity (WHC) were estimated using the following formulae (Zayas and Lin 1988):

$$\text{Cooking yield}(\%) = \frac{\text{Weight of cooked patty}}{\text{Weight of uncooked patty}} \times 100$$

$$\text{Fat retention capacity}(\%) = \frac{\text{Cooked weight} \times \text{fat}(\%) \text{ in cooked patty}}{\text{Uncooked weight} \times \text{fat}(\%) \text{in uncooked patty}} \times 100$$

$$\text{WHC} = 1 - \frac{\text{Meat film area}}{\text{Total film area}}$$

Total plate counts were determined using tryptone glucose yeast extract agar after incubating the plates at 37°C for 48 h (Sehgal et al. 2008). Six-member panel of judges evaluated fried patties for appearance, colour, flavour, taste, texture (firmness), and overall acceptability on a 9-point Hedonic Scale (Pigott 1984). The results were analyzed by ANOVA using STATGRAPHICS and MICROSOFT EXCEL statistical packages.

Results are presented in Table 1. Patties containing boiled potato had higher moisture content than corn flour patties as also reported for rohu fish patties (Sehgal et al. 2008). The moisture content was close to that of patties prepared from *Catla catla* (66.4 in uncooked and 62.1% in cooked) and chicken meat patties (62.3–69.2% in uncooked and 52.1–56.4% in the cooked).

The crude protein content of the uncooked patties varied between 27.8 and 33.3%. The differences in crude protein with respect to the weight groups of the fish and extenders used in the preparation of the patties were narrow. Potato resulted in higher protein content of patties. The total lipid content of the uncooked patties varied between 2.6 and 4.8%. Patties with potato had higher lipid content than those with corn flour. Similarly, patties prepared from 501 to 750 g weight group of the fish had the highest lipid content, which was, however, much lower than in those made from *N. japonicus* (28.9%) (Raju et al. 1998). This is because *N. japonicus* is more fatty fish than *C. carpio*. Cooking resulted in a significant increase in lipid content of patties (up to 4.7%) as also recorded for the patties prepared from another freshwater fish, *C. catla*.

Total soluble sugars content in uncooked patties was minimum (6.9%) in patties from 250 to 500 g weight group using corn flour as the extender and maximum (10.2%) in patties from 751 to 1,000 g weight group using potato as the extender. The soluble sugars content of patties increased with increase in the weight of fish. Cooking resulted in an increase (up to 3.7%) in total soluble sugars content of patties.

Patties prepared from the higher weight group with corn flour had higher gross energy and those using the same fish weight group but with potato as the extender had minimum gross energy. The energy values of fish patties increased on frying due to increase in lipid and soluble sugars contents.

The minimum cooking yield (80%) was obtained from the patty prepared from 250 to 500 g weight group using potato as the extender. Usually, the patties prepared using corn flour gave higher cooking yield than those prepared using boiled potato. Dawood et al. (1983) made similar observation that the addition of cornmeal and soy protein in combination with sodium chloride improved cooking yield of fish sausages developed from freshwater suckers. Cooking yield (85.1–93.5%) of the *L. rohita* patties (Sehgal et al. 2008) was higher than that of the carp patties.

The patty prepared from the 751–1,000 g group using corn flour had the highest fat retention capacity. The same was true for the patties prepared from *L. rohita* (Sehgal et al. 2008).

The patty prepared from the 250–500 g group using corn flour had maximum (0.62%), and the one prepared from the 501–750 g group using potato had the minimum (0.47) water holding capacity. Similar observation has been made

Table 1 Quality characteristics of patties prepared from carp fish of different weight groups containing potato and corn flour

	Fish weight, g					
	250–500		501–750		751–1,000	
	P	C	P	C	P	C
Physical (n=3)						
Cooking yield, %	80.0±1.44^{b}	82.6±0.83 ^{b}	84.3±1.15 ^{ab}	87.9±1.60 ^{a}	83.6±0.58 ^{ab}	83.1±1.07 ^{a}
Fat retention capacity, %	177.9±9.72^{c}	209.3±0.47 ^{b}	160.7±2.65 ^{d}	201.9±1.33 ^{b}	152.3±2.97 ^{d}	227.7±4.45 ^{a}
Water holding capacity	0.55±0.01^{ab}	0.62±0.02 ^{a}	0.47±0.06 ^{c}	0.54±0.01^{bc}	0.57±0.03^{ab}	0.51±0.02^{bc}
Chemical (n=3)						
Moisture, %						
Uncooked	72.0±1.73^{a}	65.2±1.22^{ab}	70.6±0.92^{a}	60.2±0.94^{b}	73.3±2.88^{a}	60.0±1.03^{b}
Cooked	60.0±1.63^{ab}	53.9±1.15^{c}	62.0±0.88^{a}	52.4±1.51^{c}	56.5±0.85^{abc}	56.2±1.01^{bc}
Protein, %						
Uncooked	31.5±2.74^{ab}	33.3±1.21^{a}	32.7±1.70^{a}	32.2±0.23^{a}	31.8±0.16^{a}	27.8±1.20^{b}
Cooked	25.9±1.28^{a}	26.1±0.84^{b}	26.6±0.35^{a}	24.4±0.56^{bc}	24.8±0.07^{bc}	23.7±0.48^{c}
Total lipids, %						
Uncooked	3.3±0.10^{d}	2.6±0.00^{e}	4.3±0.11^{b}	3.8±0.06^{c}	4.6±0.02^{a}	2.7±0.00^{c}
Cooked	7.3±0.10^{b}	6.7±0.02^{c}	8.2±0.80^{a}	6.6±0.09^{c}	6/6±0.09^{a}	7.5±0.05^{b}
Soluble sugars, %						
Uncooked	7.5±0.00^{cd}	6.9±0.63^{d}	8.9±0.63^{b}	8.2±0.75^{bc}	10.2±0.50^{a}	7.9±0.38^{bcd}
Cooked	9.0±0.50^{d}	10.7±0.25^{c}	12.2±0.25^{b}	11.5±0.50^{bc}	14.0±0.50^{a}	11.2±0.75^{bc}
Gross energy, kcal/100 g						
Uncooked	231.0±14.72^{bc}	245.4±9.46^{ab}	252.3±8.12^{a}	252.1±1.23^{a}	256.7±4.96^{a}	215.5±4.96^{c}
Cooked	250.5±7.82^{c}	253.4±8.68^{c}	292.3±1.65^{a}	245.0±6.05^{c}	274.4±0.53^{b}	248.5±5.26^{c}
Sensory (n=6 panelists, score on 9-point Hedonic scale)						
Appearance	7.7±0.49^{a}	8.3±0.33^{a}	8.0±0.26^{a}	8.5±0.22^{a}	7.7±0.56^{a}	7.8±0.31^{a}
Colour	7.8±0.48^{a}	8.5±0.22^{a}	7.7±0.21^{a}	8.3±0.33^{a}	7.7±0.49^{a}	8.1±0.26^{a}
Flavour	7.8±0.48^{ab}	7.3±0.42^{b}	8.3±0.33^{a}	8.3±0.33^{a}	8.0±0.25^{ab}	8.3±0.21^{a}
Taste	7.7±0.21^{a}	7.5±0.34 ^{a}	8.3±0.21^{a}	7.7±0.56^{a}	7.8±0.40^{a}	8.3.±0.33^{a}
Texture	7.3±0.49^{c}	7.7±0.22^{bc}	8.9±0.33^{a}	8.±2 0.31^{ab}	8.2±0.31^{ab}	8.0.±0.00^{bc}
Overall quality	7.3±0.33^{c}	7.5±0.22^{bc}	8.3±0.33^{a}	7.8±0.31^{bc}	8.0±0.37^{b}	8.2±0.17^{ab}
Microbial log cfu/g (n=3 total plate counts)						
Uncooked	6.1±0.03^{a}	6.1±0.04^{a}	6.0±0.03^{a}	6.1±0.05^{a}	6.1±0.03^{a}	6.1±0.04^{a}
Cooked	4.0±0.02^{a}	4.0±0.03^{a}	3.9±0.07^{a}	3.9±0.05^{a}	3.9±0.06^{a}	3.8±0.05^{a}

Values with different superscripts in a row for each parameter differ significantly ($p \leq 0.01$)

P boiled potato, *C* corn flour

for the patties prepared from *L. rohita* in which the water holding capacity varied between 0.49 and 0.62 (Sehgal et al. 2008).

The total plate count (TPC) of the fresh patties on the day of preparation ranged between log 6.0 and log 6.1 cfu/g. The cooked patties had a TPC of log 3.8–4.0 cfu/g on the day of preparation. Similar observation has been made for the patties prepared from different weight groups of rohu (Sehgal et al. 2008). The patties were safe from the microbial load point of view as the TPC were below the permissible limit of log 6.7 cfu/g. The levels exceeding log 7 cfu/g and log 8 cfu/g are generally considered unfit for human consumption (Ulrike et al. 2000).

There were no significant ($p>0.05$) differences in the appearance, colour, and taste of the fish patties prepared using different weight groups of the fish or different extenders. The patties prepared from 501 to 750 g group using both boiled potato and corn flour and those prepared from 751–1,000 g group using corn flour scored maximum for flavour. Gopakumar (1997), and Lipincott and Lee (1983) reported that the starches of potato having high amylopectin content gave cohesive gels as compared to

cornstarch (having low amylopectin content), which increased rigidity and firmness of gels and thus gave better firmness/texture to the finished product. Dawood et al. (1983) also observed that addition of cornmeal and soy protein in combination with sodium chloride improved texture of fish sausage. Chidanandaiah and Keshri (2007) recorded an increase in the sensory score for crispness and adherence of batter of buffalo meat patties coated with batter mix prepared from corn flour (either alone or in combination with Bengal gram flour). Similarly, Bawa et al. (2008) observed that Bengal gram flour with baking as processing treatment registered highest sensory scores.

Conclusion

Patties prepared from the 501–750 g group of common carp, using boiled potato as the extender were rated as the best. These patties had slightly lower crude protein, total lipids and cooking yield, and slightly higher total soluble sugars than those prepared from rohu (Sehgal et al. 2008). Moisture content, fat retention capacity, and water holding capacity in the common carp and rohu patties were comparable.

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