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Research Article

HEAT PENETRATION AND ORGANOLEPTIC QUALITY OF FISH BALL IN CURRY PROCESSED AT ELEVATED TEMPERATURE

Shini T. George, Joshi V.R., Sonavane A.E., *Koli J.M. and Kale M.C.
College of Fisheries Shirgaon, Ratnagiri. Maharashtra (India)
**Author for Correspondence*

ABSTRACT
In the present study, an attempt was made on the thermal processing of fish ball in curry in retort pouches. Fish ball in curry was processed and packed in retort pouches of 300 g capacity having a configuration of 12 µ PET, 9 µ Al foil, 15 µ biaxially oriented nylon and 70 µ CPP duly laminated. About 100g fish ball and 200g curry were packed in retort pouches of size150 mm × 200 mm. Air inside the pouch was exhausted by steaming, heat sealed and processed at 115^{o} C to F_0 values of 8 minutes and 6 minutes. Wet ingredients incorporated fish balls and plain fish balls were subjected to thermal processing at these F_0 values of 8 minutes and 6 minutes. The total process period was found to be 90 minutes for wet ingredients incorporated fish ball in curry processed at 115 ^{o}C to an F_0 value of 8 minutes. The total process period for wet ingredients incorporated fish ball in curry product, plain fish ball in curry product, plain fish balls and wet ingredients incorporated fish balls were found to be 74 minutes, 77 minutes, 90 minutes and 93 minutes respectively. The product was then subjected to physical, biochemical and organoleptic evaluation. Process of F_0 value of 6 minutes was found to be sufficient for fish ball in curry product and fish balls without curry to obtain acceptable product.

Keywords: *Fish Ball in Curry, Retort Pouch, F_0 Values, Plain Fish Balls, Weight Ingredients Incorporated Fish Ball*

INTRODUCTION
Trash fishes are very useful for the production of surimi and various types of products can be prepared economically from the surimi. Emulsion type fish paste products are traditional products of Japan. These products are relished for high gel strength, white in colour and bland taste characteristics. These products as such are not suitable for Indian palate and therefore, many attempts have been made to develop various emulsion type fish paste products suitable to Indian palate such as fish ball in curry, fish ball with various vegetable ingredients, kamaboko with various vegetable ingredients, fish bakarwadi etc. These products are either consumed fresh or chilled for short term storage (Balange, 1999; Desai, 1999; Subhedar, 1999; Fernandes, 2000; Mote, 2000) or frozen stored for long term storage (Desai, 2003; Temburne, 2005). For storage at room temperature, these emulsion type fish paste products require high temperature processing after packing in the cans or in the retort pouch.
However, so far no work has been done in the thermal processing of fish ball in curry in retort pouch. So in the present study, an attempt has been made on the processing of fish ball in curry packed in retort pouches.

MATERIALS AND METHODS
Frozen surimi prepared from pink perch (*Nemipterus japonicus*), was procured from a commercial factory and stored in deep freezer until further use.
Frozen surimi was taken out and thawed before use. Fish ball in curry was prepared according to the recipe (Appendix I) of Joshi *et al.,* (2011) but with a slight modification, i.e., usage of surimi instead of fish mince.
Curry paste was prepared according to the recipe of Joshi *et al.,* (2011). Oil was heated in a container and sliced onion was fried in the oil till brownish colour and ground into fine paste. Similarly sliced tomato was fried in oil and made into paste. Oil was heated in a container, then garlic paste, coriander leaves paste, green chilly paste, ginger paste, coriander seed powder, red chilly powder and garam masala were

added in oil and fried. Then salt, onion paste, tomato paste, turmeric powder were added and heated. The above curry paste was mixed with oil and heated for 2 minutes, and mixed with water in 1:1 ratio and boiled for 5 minutes

Small quantity of oil was heated, turmeric was added and heated. Then tomato paste and onion paste were added and heated for 1 minute. Surimi was added to the silent cutter, run for 2 minutes so that the meat was cut into fine pieces. Salt was added and ground for 2 minutes. The soft flesh becomes viscous paste. Starch was added and the grinding continued for 2 minutes. Red chilly powder, coriander seed powder, garam masala, garlic paste, ginger paste, coriander leaves paste, green chilly paste were added to the fish paste and also the previously prepared turmeric – tomato - onion mixture was added and ground for 4 minutes to achieve uniform mixing. Fish ball paste weighing 10g was moulded into round balls and subjected to steaming at 100^0 C (0 psi) for 10 minutes. Steamed balls were mixed with boiled curry. The fish ball and liquid curry so prepared were used for further studies.

Control samples were prepared as above except pasteurization of fish balls, i. e. fish balls were steamed at 100^0 C for 45 minutes.

Retort pouches (150 mm × 200 mm) of 300g capacity having a configuration of 12 µ PET, 9 µ Al foil, 15 µ biaxially oriented nylon and 70 µ CPP duly laminated were used for packaging of fish ball in curry.

Wet ingredients incorporated fish balls and plain fish balls were prepared by mixing surimi, starch and salt along with wet ingredients and without any ingredients respectively.

Heat Penetration Study and Process Value

Heat penetration characteristics of wet ingredients incorporated fish ball in curry product processed to an F_0 value of 8 minutes

Instruments required for heat penetration study was thermocouple glands, probes and washers of Ellab, Denmark make were used for taking the temperature readings and temperature scanner module of Ellb TM 9616, Denmark make and computer were used during the heat penetration studies (CIFT, Cochin), for determination of F0 value.

The cold spot for fixing the tip of the thermocouple was decided based on the reports of work done by the following authors. The thermocouple tip is normally held at the anticipated pack centre or, in the case of products containing particles of appreciable size, at the centre of a selected piece of solid food (Hersom and Hulland, 1980). The tips of thermocouple were introduced into the centre of fish piece such as seer fish piece (Manju *et al*., 2004) and mackerel fish piece (Ravishankar *et al*., 2008). Based on these suggestions the tip of the thermocouple was fixed at the geometric centre of fish ball for heat penetration studies.

A piece of tesa tape was pasted at the bottom centre of each pouch and a hole was made by using a puncture tool. The thermocouple glands were inserted into the retort pouch through the bottom hole with a washer on each side of the pouch. Then the thermocouple glands were tightened using a nut from the inner side of the pouch. Three fish balls were attached to the thermocouple gland so that the tip of the thermocouple gland was positioned at the geometric centre of the third fish ball. Fish balls were placed into the retort pouch to the total weight of 100 g. Then 200 g of curry was filled into each pouch. Utmost care was taken to avoid the contamination of seal area. The pouches were steam exhausted, sealed using a sealing machine and again an additional sealing was given using an impulse sealer. The thermocouple probes were inserted into the thermocouple gland through the hole at the bottom in such a way that the tip of the thermocouple probe where the temperature scanner is located, was reached upto the tip of the thermocouple gland.

Similarly four more pouches were prepared along with the thermocouple as above. These pouches were placed at different positions in the autoclave and the remaining pouches without the thermocouples but with the fish ball and curry were placed in the overpressure autoclave. A thermocouple was placed inside the retort for measuring retort temperature. The thermocouple probes were then connected to the temperature scanner module, which was connected to the computer. The retort was started, air was vented out, valves were closed and temperature was allowed to rise upto 115 ^{0}C, which was maintained by controlling the steam. The product was then subjected to heat penetration at a F_0 value of 8 minutes. The

temperature achieved at the cold spot of the product packed in the retort pouch was noted for different durations which included come-up time, processing period and cooling period. The experiment was done following the standard procedure of the retort operation, maintaining the temperature at 115 ^{0}C and the readings were taken at regular intervals. When the F_0 value was 5.11 minutes, steam was cut off (a total of 67 minutes from come up time of retort to steam cut off), so that the final F_0 value reached 8 minutes and cooling started by injecting water using a pump and simultaneously providing air also to maintain the internal pressure about 25 psi. Cooling continued till the product temperature was below 60 ^{0}C. Then pumping of water was stopped and air pressure valve closed. The water was drained out, retort was opened and the pouches were taken out. The product was then subjected to physical, chemical and organoleptic analysis.

Heat penetration characteristics of wet ingredients incorporated fish ball in curry product processed to an F_0 value of 6 minutes

Heat penetration study of curry paste incorporated fish ball in curry product was carried out with same procedure as at above method at an F_0 value of 6 minutes. When the F_0 value was 4.31 minutes, steam was cut off (a total of 45 minutes from come up time of retort to steam cut off), so that the final F_0 value became 6 minutes and cooling started and the same procedure was followed. Finally the pouches were taken out and the product was then subjected to physical, chemical and organoleptic analysis.

Heat penetration characteristics of plain fish ball in curry product Processed to an F_0 value of 6 minutes

Heat penetration study of plain fish ball in curry product was carried out with same procedure as at above method at an F_0 value of 6 minutes. When the F_0 value was 5.21 minutes, steam was cut off (a total of 48 minutes from come up time of retort to steam cut off), so that the final F_0 value reached 6 minutes and cooling started and the same procedure was followed. Finally the pouches were taken out and the product was then subjected to physical, chemical and organoleptic analysis.

Heat penetration characteristics of plain fish balls processed to an F_0 value of 6 minutes

Heat penetration study of curry paste incorporated fish balls was carried out with same procedure as at above method but without curry at an F_0 value of 6 minutes. When the F_0 value reached 5.10 minutes, steam was cut off (a total of 67 minutes from come up time of retort to steam cut off), so that the final F_0 value was 6 minutes and cooling started and the same procedure was followed. Finally the pouches were taken out and the product was then subjected to physical, chemical and organoleptic analysis.

Heat penetration characteristics of wet ingredients incorporated fish balls processed to an F_0 value of 6 minutes

Heat penetration study of curry paste incorporated fish balls was carried out with same procedure as at above method at an F_0 value of 6 minutes. When the F_0 value reached 5.11 minutes, steam was cut off (a total of 67 minutes from come up time of retort to steam cut off), so that the final F_0 value became 6 minutes and cooling started and the same procedure was followed. Finally the pouches were taken out and the product was then subjected to physical, chemical and organoleptic analysis.

Analytical Method

As per commercial sterility test (IS: 2168-1971), the thermally processed samples to different F_0 values were incubated at 37^0 C for 15 days and 55^0 C for minimum of 5 days. The incubated can were aseptically opened and 1-2 gms of the samples were taken by a sterilized forceps and inoculated into the sterilized fluid thioglycolate broth in test tubes. Little sterilized liquid paraffin was put on to the top of the broth to create anaerobic condition and incubated at 37^0 C for 48 hrs and at 55^0 C for 4 days (IS: 2168-1971). Physical parameter such as Expressible water percentage and folding test were estimated by following the method as per Suzuki (1981). Expressible water was expressed as percentage and gel strength expressed as grade. Organoleptic analysis, sensory evalution was based on the various sensory characters i.e., appearance, colour, taste and texture. A panel of 10 judges performed the sensory analysis of samples. The samples were evaluated by a 10 point scoring system. High score good quality and vice-versa.

RESULTS AND DISCUSSION

According to a commercial sterility of low acid canned foods (LACF), it is mandatory to process all LACF to an F_0 value not less than 3 minutes. In practice, the process is usually higher than this minimum F_0 of 3 minutes owing to some probability of underprocess and spoilage from heat tolerable organisms. Depending upon the product and the climatic conditions of storage, a typical F_0 value used operationally for fish and meat products generally varies in the range of 5-20 minutes (Bratt, 1995; Pflug and Christensen, 1980).

Runglerdkriangkrai *et al.,* (2006) suggested a maximum process value of F_0 = 6 min at 116 ^oC for canned fish balls in brine. However, products containing starch and spices may contribute a maximum number of microorganisms with higher level of heat resistance. Hence, Saralaya *et al.,* (1978) suggested that thermal processes equivalent to F_0 = 5.2 may be taken as minimum and those with F_0 = 12 as maximum for canned fish sausages prepared under hygienic conditions using good quality raw materials. Therefore, a process value of F_0 = 8 min was chosen for the heat penetration studies.

In the present study, the come-up time of wet ingredients incorporated fish ball in curry product packed in retort pouch to achieve a processing temperature of 115 ^oC was found to be 74 minutes, cooling period of 16 minutes was noted. The total process value was considered based on the minimum requirement of destruction of *Clostridium botulinum* spores and the maximum value considering the heat resistance of prevalent high heat resistant organisms and the retention of nutritive value and better organoleptic qualities of the fish ball in curry product. Based on this, the total process value was determined to be 90 minutes processed at 115^o C for wet ingredients incorporated fish ball in curry with the corresponding F_0 value of 8 minutes.

As per table 1 colour of wet ingredients incorporated fish balls in curry product processed to an F_0 value of 8 minutes was found to be slightly darker as compared to steamed fish ball in curry product and the texture was also slightly poor. The other organoleptic quality was also poor. Expressible water and gel strength were lower.

The come up time of fish ball in product of type A, B, C, D and E cause found to be 74, 50, 74, 51 and 73 minutes respectively and the cooling period of these were 16, 23, 16, 22 and 20 minutes respectively. The total process value determine to 90, 74, 93, 77 and 90 minutes respectively of processed at 115^0 with the corresponding process value of $F_0$8, $F_0$6, $F_0$6 and $F_0$6 respectively.

The organoleptic characteristic of fish balls products showed that Type E found that superior than others followed by D, C, B, A and was found to be inferior. However the high taste of D & E were slightly lower than B & C due to lack of curry ingredients. The control samples (steamed product) was better than the thermal process sample in respect to organoleptic quality. Among the treated samples type A was found to be rejected with very low score. among the treated the samples type A had high expressible water was higher and low gel strength as compare to B, C, D, E and control samples. Among the treated samples type E was found to be better followed by D, C and B.

Although the process value for any product is considered based on the minimum requirement of destruction of *Clostridium botulinum,* it is essential to consider the effect of heating (CUT, PP,CP) from the perspective of high heat resistance organisms (higher than *Clostridium botulinum*), retention of nutritional quality and organoleptic quality. In the present study, the above factors have been considered.

The colour of wet ingredients incorporated fish ball in curry product processed to an F_0 value of 6 minutes was found to be better than that of F_0 value of 8 minutes (table 1) and it was almost similar to steamed fish ball in curry product. The texture was also better than F_0 value of 8 minutes. Therefore, F_0 value of 6 minutes was considered for further studies.

The Sterility test, the products showed no growth after processing and during the end of storage study, which indicates the process given, were sufficient to attain sterility. Similarly, reports have been made that the higher process values (higher temperature of heating or longer duration of heating) resulted in loss of textural and other quality attributes of canned fish sausages (Saralaya *et al*., 1978) and canned fish balls in brine (Runglerd *et al*., 2006) unlike that of lower process values for canned fish sausages in brine, oil pack and dry pack and for canned fish balls in brine respectively.

Conclusion

Among the treated samples Type E was found to be superior followed by D, C, B and Type A was found to be poor. Among the different process values, F_0 value of 6 minutes was found to be superior in all aspects as compared to F_0 value of 8 minutes.

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Appendix I

Standardized Recipe of Fish Ball

Sr no.	Ingredients	Quantity in gram
1	Surimi	1000
2	Salt	20
3	Starch	150
4	Curry paste*	400
5	Total	1570

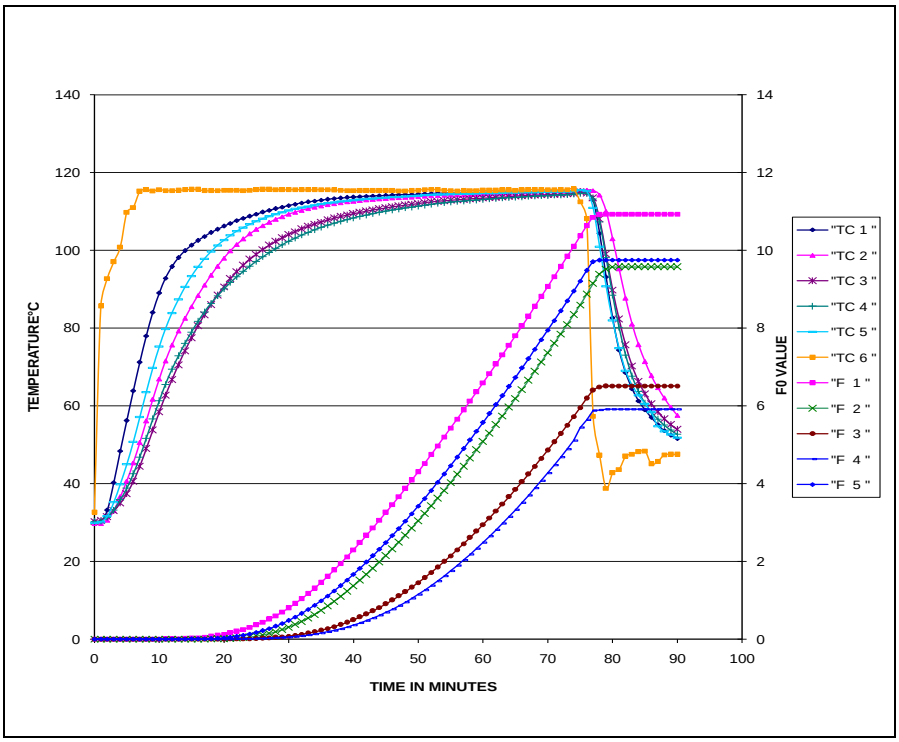

Figure 4.3: Heat penetration characteristics of wet ingredients incorporated fish ball in curry product processed to an F_0 value of 8 minutes

Note: TC – thermocouple; F – F_0 value

Table 1

	Steamed Fish balls (Control) 100^{0}C for 30 minutes	**Fish ball curry processed at F_0 8 (Type A)**	**Fish ball curry processed at F_0 6 (Type B)**	**Fish ball without curry processed at F_0 6 (Type C)**	**Plane Fish ball curry processed at F_0 6 (Type D)**	**Plane Fish ball without curry processed at F_0 6 (Type E)**
Appearance	9.0	3	8.2	8.5	8.6	8.7
Colour	9.2	4	8.4	8.6	8.7	8.8
Flavour	9.4	3	8.3	8.5	8.6	8.8
Taste	9.1	4	8.0	8.6	8.7	8.9
Texture	9.9	5	8.1	8.5	8.0	7.8
Overall Acceptability	9.3	4	8.2	8.5	8.6	8.7
Expressible water	4.1 %	29.4	4.0 %	4.2 %	4.3 %	4.1 %
Gel Strength	AA	D	AA	AA	AA	AA

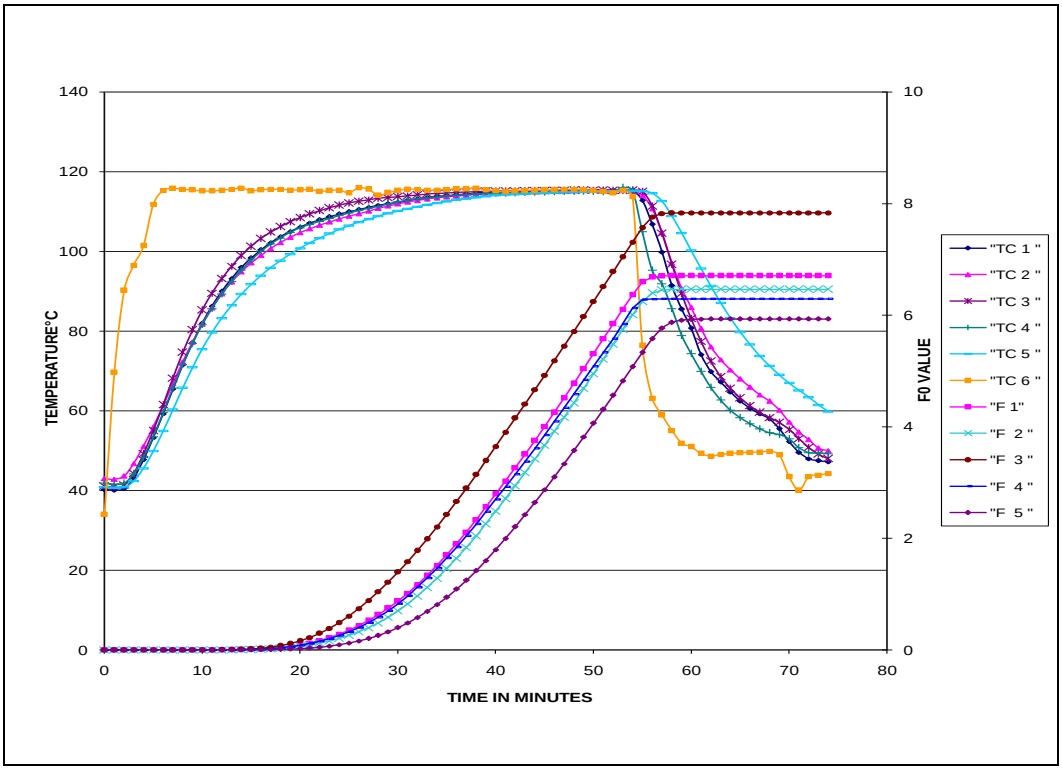

Figure 4.4: Heat penetration characteristics of wet ingredients incorporated fish ball in curry product processed to an F_0 value of 6 minutes
Note: TC – thermocouple; F – F_0 value

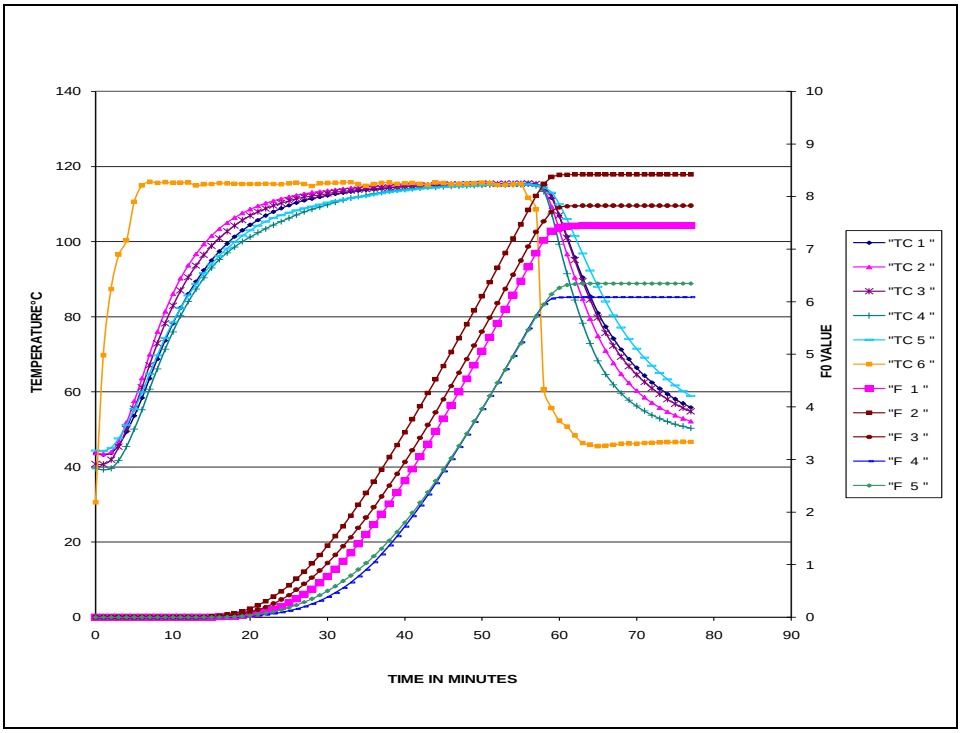

Figure 4.5: Heat penetration characteristics of of plain fish ball in curry product processed to an F_0 value of 6 minutes
Note: TC – thermocouple; F – F_0 value

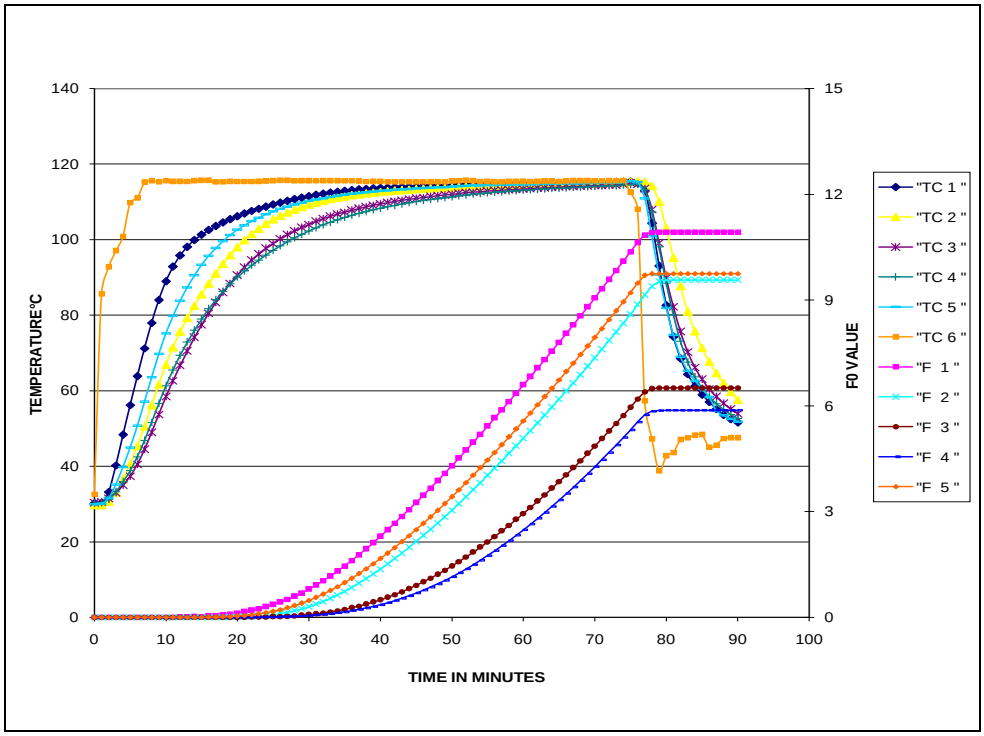

Figure 4.6: Heat penetration characteristics of plain fish balls processed to an F_0 value of 6 minutes
Note: TC – thermocouple; F – F_0 value

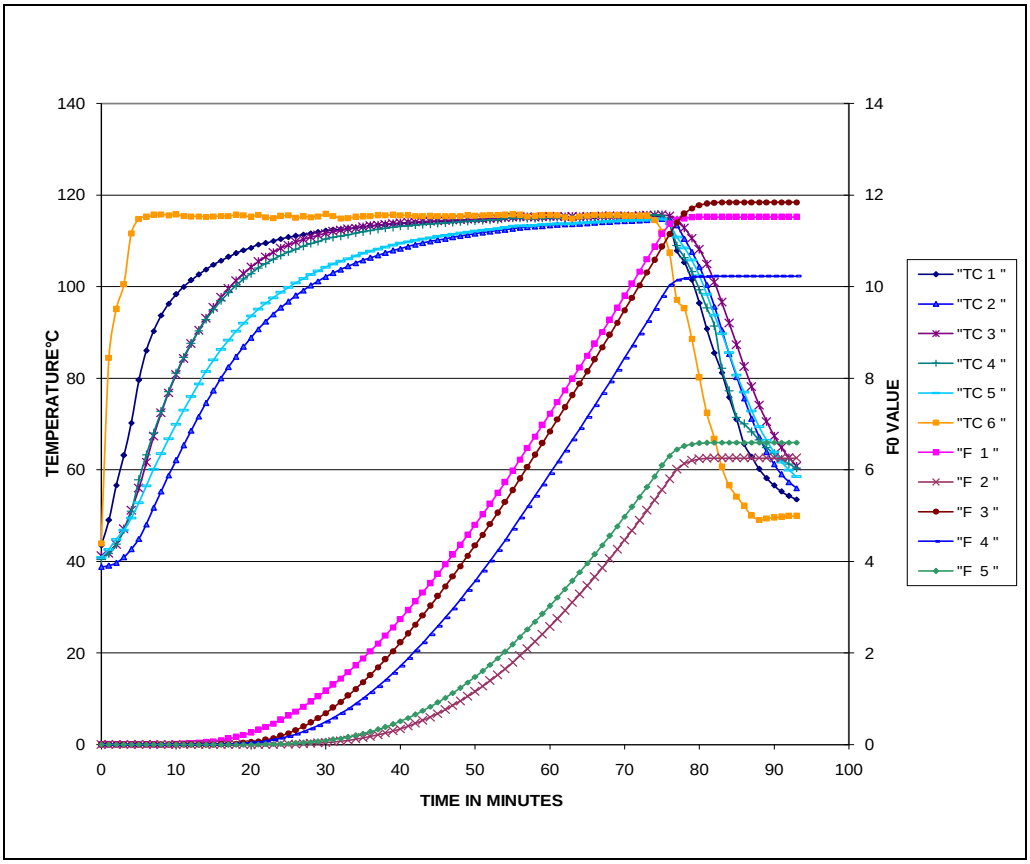

Figure 4.7: Heat penetration characteristics of wet ingredients incorporated fish balls processed to an F_0 value of 6 minutes
Note: TC – thermocouple; F – F_0 value

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