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Quality improvement of fish ball in curry processed at elevated Temperature

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Abstract

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 improve the quality of fish ball in curry product, different methods such as effect of setting, types of starch, levels of wet ingredients, different types of ingredients and pack and levels of transglutaminase enzyme were adopted to find out a suitable method and subjected to biochemical (pH and moisture), physical (gel strength and expressible water percentage) and organoleptic evaluation. Of the different methods tried, levels of wet ingredients and different types of ingredients and pack showed an improvement in texture. Texture of fish balls showed an improvement with a reduction in the levels of wet ingredients.

Plain fish balls without the curry (dry pack) showed superior texture followed by plain balls with curry, fish balls with wet ingredients packed dry. Although wet ingredients incorporated fish balls in curry had lower textural values (A grade in folding test and organoleptic textural score of 8.4), it was liked by the panelists as they preferred soft texture to rubbery ones.

Introduction

Non-starch polysaccharides (NSP) are some important anti-nutritive components in plant based feed stuffs. Exogenous enzymes can hydrolyze these NSP into smaller units that can be utilized by pigs (Partridge and Bedford, 2000). Similarly phosphorus from plants is of low bio-availability to swine and poultry as a result of phytate, the principal form of phosphorus storage in plants, being relatively indigestible by non-ruminants (NRC, 1998). Exogenous supplementation of feeds with phytase has demonstrated the ability to increase phosphorus bio-availability and thus growth rates in pigs by cleavage of phosphorus molecule from phytase. Since four decades, concern about antibiotic resistance has increased worldwide (Cromwell, 2002). The ban on some Antibiotic Growth Promoters lead to think on phytogenic feed additives which include herbs and their residues, essential oils, botanicals, extracts etc. The mode of action of plant active substances include improvement of endogenous enzyme secretions, stimulation of the appetite, improvement of the digestibility and absorption of nutrients, promote proliferation of beneficial bacteria like Lactobacillus spp. in the gut. Hence the present experiment was planned with the objective of studying the effect of exogenous enzymes on pig performance either with or without herbal residues and their role in gut pathogen inhibition in finishers.

Materials and methods

Five experimental diets (Table 1) were formulated as per NRC (1998) requirements and were evaluated Frozen surimi was taken out and thawed before use. Fish ball in curry was prepared according to the recipe of Joshi *et al.*, (2011) with a slight modification, but with

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slight modifications i.e., such as usage of surimi instead of fish mince, overnight setting, reducing the quantity of wet ingredients, usage of dry ingredients instead of wet ingredients, use of different types of starch, incorporation of transglutaminase enzyme.

Curry paste was prepared according to the recipe of Joshi *et al*., (2011). The curry paste was mixed with oil and heated for 2 minutes, and mixed with water in 1:1 ratio and boiled for 5 minutes.

Fish ball paste was prepared by mixing all the ingredients. Fish ball paste weighing 10g was moulded into round balls and steamed at 100^0 C (0 psi) for 15 minutes.

The fish ball and liquid curry so prepared were used for further studies.

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

Fish balls were kept for overnight at 0^0 C, brought to room temperature, steamed at 100^0C (0 psi) for 30 minutes, packed in retort pouch along with curry (fish ball 100g and curry 200g), sealed, washed, stacked in retort and subjected to thermal processing at 115^0C for 45 minutes, steam was shut off and simultaneously air and water was pumped inside the retort to maintain the internal pressure bought 25 psi and cooling continued inside the retort till the temperature at cold spot of the product inside the pouch reached below 60^0C. Afterwards the pouches were wiped dry and stored until used fish ball in curry product was subjected to physical, chemical and organoleptic analysis. In the case of control, fish balls were prepared without setting, steamed for 30 minutes, packed in retort and subjected to thermal processing at 115^0C for 45 minutes. In the case of different types of starch, five sets of fish ball paste were prepared by mixing the different types of starches such as corn starch, modified starch, wheat starch, tapioca starch and control was without starch. The rest of the followed was as above (minus setting procedure). In the case of different levels of wet ingredients, quantity of wet ingredients was reduced in each set in a sequential manner and finally in the last set wet ingredients was not added.

All the other ingredients were kept constant. The rest of the followed was as above (except starch variation). In the fourth experiment, three sets of fish ball were prepared by mixing various types of ingredients such as wet ingredients, dry ingredients and without ingredients along with surimi, starch and salt. The rest of the followed was as above. Similarly in another experiment fish balls were packed (150g), sealed, subjected to thermal processing at 115^0C for 67 minutes for both plain fish balls and wet ingredients incorporated fish balls. The product so prepared was subjected to physical, chemical and organoleptic analysis. In the fifth experiment, five sets of fish ball paste were prepared by mixing the various ingredients with different concentrations of transglutaminase enzyme in the fish ball paste such as 0.1%, 0. 2%, 0.3%, 0.4% and control was without enzyme. The rest of the followed was as above.

Table 1: 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

Table 2: Recipe of curry paste

Sr. No.	Ingredients	Quantity in gram	
		WI	PB
1	Fried onion paste	246.06	-
2	Dried onion powder	-	-
3	Fried tomato paste	49.21	-
4	Garlic paste	33.46	-
5	Dried garlic powder	-	-
6	Chilly powder	8.24	-
7	Turmeric powder	3.69	-
8	Coriander seed powder	6.15	-
9	Garam masala	8.7	-
10	Green chilly paste	8.95	-
11	Coriander leaves paste	8.95	-
12	Dried coriander leaves powder	-	-
13	Ginger paste	4.05	-
14	Dried ginger paste	-	-
15	Salt	22.5	-
16	Total	399.96	-

Note: WI – wet ingredients; PB – plain fish ball

Table 3: Recipe of curry paste for liquid curry

Sr. No.	Ingredients	Quantity in gram
1	Onion	526.6
2	Tomato	394.9
3	Garlic paste	27.2
4	Chilly powder	6.6
5	Turmeric powder	2.6
6	Coriander seed powder	4.0
7	Garam masala	3.3
8	Green chilly	7.3
9	Coriander leaves	7.3
10	Ginger paste	3.3
11	Salt	18.3
12	Total	1001.4

Results and Discussion

Based on the heat penetration studies , an F_0 value of 6 min was found to be sufficient The come-up time of wet ingredients incorporated fish ball in curry product packed in retort pouch to achieve a processing temperature of 115^0C was found to be 50 minutes, cooling period of 23 minutes was noted and the total process value was determined to be 74 minutes at 115^0C. The come-up time of plain fish ball in curry product packed in retort pouch to achieve a processing temperature of 115^{0}C was found to be 51 minutes, cooling period of 22 minutes was noted. The total process period at 115 ^{0}C was found to be 77 minutes. The come-up time of plain fish balls packed in retort pouch to achieve a processing temperature of 115^{0}C was found to be 74 minutes, cooling period of 16 minutes was noted and the total process period was found to be 90 minutes at 115^{0}C. The come-up time of curry paste incorporated fish balls packed in retort pouch to achieve a processing temperature of 115^{0}C was found to be 73 minutes, cooling period of 20 minutes was noted and the total process period was found to be 93 minutes at 115 ^{0}C Of the five methods tried, three methods, i.e., effect of setting, effect of different types of starch and different levels of transglutaminase enzyme did not improve the qualities of fish ball in curry after thermal processing, as compared to steamed ones. In all these methods, the values of pH, folding test grades and organoleptic qualities were found to be decreased; the values for moisture and expressible water percentage were found to be increased after thermal processing.

Similar observations have been made by Saralaya *et al.* (1978) for canned fish sausages in brine, oil pack and dry pack and Runglerdkriangkrai *et al.* (2006) for canned fish balls in brine.

In the case of fish ball prepared with different levels of wet ingredients, the steamed fish balls (control) prepared with normal procedure was found to better as compared to the thermally processed fish balls prepared with different levels of wet ingredients. However, the fish balls prepared with lower levels of wet ingredients were found to be as good as steamed fish balls (control).

The pH of fish balls prepared with different levels of wet ingredients did not show much variation in the values of pH ranging from 6.01 ~ 6.4. It can be seen that there was a slight increase in pH as the levels of wet ingredients reduced. This may be due to the increase in the amount of moisture content and reduction in the quantity of tomato paste, thereby increasing the pH value to the alkaline side. Balange (1999), Desai (2003) and Temburne (2005), reported a pH of 5.9, 5.98 and 5.98 respectively for the fish ball in curry product, which were steamed (100^{0}C, 0 psi).

The moisture content of fish ball paste prepared with different levels of wet ingredients did not show much variation with the values ranging from 59 ~ 64%. However, the moisture content of fish balls was found to be increased after steaming. Similar trends were also observed in the case of thermally processed fish balls. This increase in moisture content may be due to the absorption of moisture from the curry.

As the quantity of wet ingredients reduced, there was a slight increase in the moisture content. This may be due to the relative increase in the quantity of surimi, as the quantity of wet ingredients were reduced, thereby resulting in the relative increase in moisture content.

With the reduction in the wet ingredients, there was found to be a decreasing trend in the expressible water percentage. The decrease was very slight in the initial stages followed by a steep decrease in the last two stages.

These results correlate well with the trends observed for folding test grades. It may be possible that the higher percentage of moisture present in the samples with higher content of wet ingredients, might interfere the formation of viscous paste and subsequent high gel products. With the higher level of moisture as well as non protein component, the myosin component become relatively lesser in quantity, leading to a low gel product with a high expressible water percentage (Suzuki,1981; Shahidi and Botta, 1994).

Unlike in the earlier experiment, it was found that there was not much decrease in the expressible water percentage (3.9 and 4 ~ 4.1% for control and samples with low and zero level of wet ingredients).

The present investigation indicates that there was not much difference in the folding test grades of fishballs subjected to thermal processing when the level of wet ingredients were reduced from 87.49 to 60.75g. However, with the further reduction there was improvement in the folding test grades of fish balls showing higher grades similar to that of control (steamed at 100 ^{o}C, 0 psi for 30 minutes). This trend is reflected in the trend observed for the expressible water percentage. This may be due to the higher levels of moisture added by way of wet ingredients of curry paste contributing to the lower folding test grades. In this connection, the criteria chosen for deciding the grades of surimi can be considered as a factor affecting the quality of the product. Among these factors, moisture content of surimi is an important parameter affecting the gel strength of kamaboko and different grades of surimi are classified based on the moisture content as super class, first class, second class and off grade (Suzuki, 1981).

Similar reports on the effect of high moisture content leading to difficulty in the preparation of meat paste from *Acetes* having low viscosity and also in moulding have been noted by Patil (2000). Bhatkar (1998) also noted similar problem while standardizing the level of moisture (10 ~ 50%) in the fish chikuwa paste subjected to microwave pasteurisation and arrived at an optimum level of moisture i.e., 35% of the fish chikuwa paste mixture.

The decrease in the folding test grades and increase in the expressible water percentage of fish balls after subjecting to thermal processing may be attributed to the loss of total SH plus SS groups which occurs by oxidation to cysteic acid or splitting to hydrogen sulphide (Nakai and Li-Chan, 1988; Yamazawa *et al*., 1979). H_2S formation from the free reacting SH groups of actomyosin starts at about 80^0C and increases exponentially with rising temperature (Hamm and Hofmann, 1965).

Organoleptic evaluation indicated that with the decrease in the content of wet ingredients incorporated in ball, there was a gradual increase in textural scores up to 34.5 g and with the further reduction, textural scores were higher. The last sample without the incorporation of wet ingredients had scores almost same as those of control i.e., steamed (100 °C, 0 psi) fish balls. This trend correlates very well with the trends observed for folding test grade and expressible water percentage.

However, the scores of taste, odor and color were significantly affected as the content of wet ingredients decreased in the fish balls. The scores of taste, odor and color were highest with the fish balls with higher content of wet ingredients unlike those with the reduced levels and particularly low scores for those without incorporation of wet ingredients.

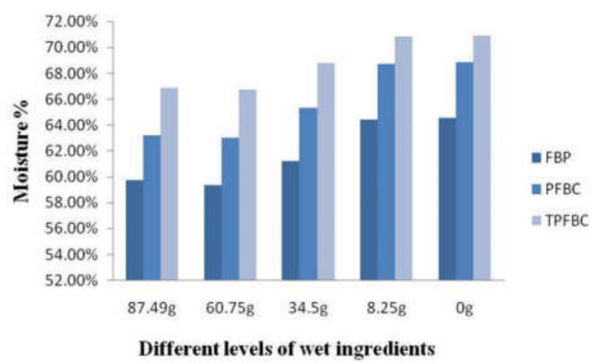

Fig. 1: Moisture percentage of fish ball product with different levels of wet ingredients

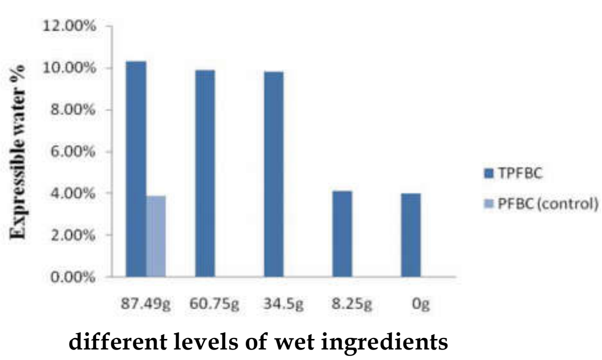

Fig. 2: Expressible water percentage of fish ball product with different levels of wet ingredients

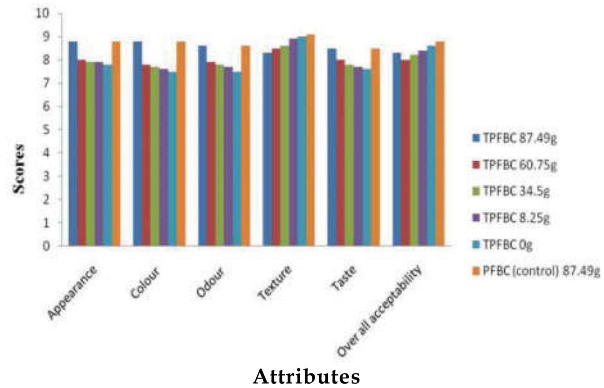

Fig. 3: Organoleptic evaluation of fish ball product with different levels of wet ingredients

In the case of different types of ingredients and types of pack, it was found that, the pH of plain fish balls were higher than the fish balls with wet ingredients. The pH of plain fish ball, thermally processed without curry was found to be higher. This may be due to the absence of tomato paste and increase in the relative concentration of surimi, thereby resulting an increase in the moisture content. The pH of plain fish balls after thermal processing with liquid curry was found to be decreased which may be due to the absorption of organic acids from the curry. Similar trend have been observed in the case of wet ingredients also. The pH of fish balls was found to be decreased on the acidic side after thermal processing without curry and it may be due to the decrease in moisture content of fish balls. The pH of fish balls prepared with dry ingredients was found to be lower after thermal processing. The reason may be the contribution of organic acids by the tomato paste and low moisture content. Balange (1999), Desai (2003) and Temburne (2005), reported a pH of 5.9, 5.98 and 5.98 respectively for the fish ball in curry product, which were steamed (100^0C, 0 psi).

The moisture content of thermally processed fish balls with wet ingredients packed along with curry showed an increase in moisture content as compared to the fish balls which were steamed at 100^0C, 0 psi for 30 minutes. However, the moisture content of fish balls with wet ingredients, subjected to thermal processing without curry showed a decrement in the moisture content. The higher levels of moisture in wet ingredients incorporated fish balls packed along with curry, and thermally processed, might be due to the entry of moisture from the curry. Similar trends have been observed in the case of plain fish balls, however, the moisture content in plain fish balls was higher as compared to that of fish balls with wet ingredients. This could be due to the relative increase of surimi as a consequence of no addition of wet ingredients and thereby increase in the moisture content in plain fish balls as compared to fish balls with wet ingredients. The moisture content present in steamed fish balls with dry ingredients was higher as compared to the other two types. This might be due to the uptake of moisture by the dry ingredients incorporated fish balls from the curry. However, the moisture content of fish balls with dry ingredients packed with curry in retort pouch decreased after subjecting to thermal processing which may be due to the lack of high gel strength forming ability of fish balls and thereby reducing the capacity to hold the moisture.

The expressible water percentage of fish balls indicate that plain balls with and without curry and fish balls with wet ingredients but without curry had lower expressible water percentage as compared to the fish balls with wet ingredients along curry. This may be due to the absorption of moisture from the curry thereby reducing the gel strength and resulting in higher expressible water percentage.

In the case of fish balls prepared with dry ingredients, the expressible water percentage values were very high and the organoleptic scores were very low and the panelists indicated that the texture was very soft. This may be attributed to the fact that with the increase in non-muscle protein components, there is relative decrease in myosin group of proteins and consequently the gel strength was lower; also the dried components which were added in large quantity having lost their functional properties may not contribute to the proper emulsion formation, and thereby interfere with the emulsion formed by the fish myosin group of proteins and affect the gel strength consequently. This might have reduced the ability to hold the moisture resulting in higher values of expressible water percentage (Shahidi and Botta, 1994).

The folding test grades of fish balls indicate that the plain fish balls with and without filling medium and fish balls with wet ingredients but without filling medium had high folding test grades as compared to the fish balls with wet ingredients along with curry. This may be due to the absorption of themoisture from the curry resulting in lower folding test grades. The plain balls had higher pH and without the curry paste ingredients, there was no contribution of organic acid from tomato and moisture from the wet ingredients of curry paste. This would have created an optimum pH of 7.2-7.3 and an optimum moisture level (super A class 79%) in the surimi. Similar justification can be attributed for higher folding test grades and lower expressible water percentage of plain balls with curry and wet ingredients but with curry. Apart from this, plain fish balls and wet ingredients incorporated fish balls did not show uptake of moisture leading to optimum moisture level.

Saralaya *et al.* (1978) reported a decrease in gel strength of canned fish sausages in natural casing (processed at 115.6 °C for 75, 45, 60 minutes for dry pack, wet pack and oil pack respectively). The difference in this and the present study may be due to the difference in preliminary treatment, composition, type of filling medium.

The decrease in the folding test grades and increase in the expressible water percentage of fish balls after subjecting to thermal processing may be attributed to the loss of total SH plus SS groups which occurs by oxidation to cysteic acid or splitting to hydrogen sulphide (Nakai and Li-Chan, 1988; Yamazawa *et al*., 1979). H_2S formation originated from the free reacting SH groups of actomyosin starts at about 80°C and increases exponentially with rising temperature (Hamm and Hofmann, 1965).

The above factor responsible for gel strength reduction due to thermal processing may not be operational in plain balls, plain balls with curry and curry paste incorporated fish balls where an environment of reduced moisture level exists due to the entrapment of the moisture within the gel matrix.

In the case of fish balls prepared with dry ingredients, the scores were very low and organoleptic scores were very low and the panelists indicated that the texture was very soft.

The organoleptic scores indicated that the textural scores of plain balls with & without curry and wet ingredients incorporated fish balls but without curry were higher compared to other samples. However, the textural scores of these fish balls were slightly lower than those of steamed (100°C, 0 psi) fish balls, i.e., the corresponding control samples (9.80-9.82).

Saralaya *et al*. (1978) reported that the textural score of canned pink perch fish sausage (in natural casing) had lower values, indicates fair quality. The decrease in the gel strength of fish balls after subjecting to thermal processing may be attributed to the loss of total SH plus SS groups which occur by oxidation to cysteic acid or splitting to hydrogen sulphide (Nakai and Li-Chan, 1988; Yamazawa *et al*., 1979).

Runglerdkriangkrai *et al*. (2006) also reported a decrease in textural scores of fish balls processed at 116°C for 30 minutes as compared to steamed (unsterilized) samples.

The organoleptic scores of appearance, taste, odor and color for plain fish balls with and without curry were lower as compared to fish balls with wet ingredients. This may be due to the less quantity of wet ingredients added in it, thereby reducing the taste and odor. The organoleptic scores of fish balls prepared with dry ingredients were lower as compared to fish balls with wet ingredients and plain balls. The scores of texture, odor and taste were very low and the panelists indicated that the fish balls were softer in texture, not good in taste, with an unfavorable odor.

The overall acceptability scores were found to be higher in the case of plain balls without curry followed by plain fish balls with curry, wet ingredients incorporated fish balls without curry and wet ingredients incorporated fish balls with curry. The overall acceptability scores of fish balls with dry ingredients were found to be lower. Although wet ingredients incorporated fish balls in curry had lower textural values (A grade in folding test and organoleptic textural score of 8.4), it was liked by the panelists as they preferred soft texture to rubbery ones.

Based on this studies, it can be concluded that plain fish balls (dry pack), plain fish balls in curry (wet pack), curry paste incorporated fish balls processed (dry pack) processed in retort pouch at 115^0 C for 45 minutes were found to retain the textural scores. However, the scores were slightly lower than the steamed samples. Curry paste incorporated fish balls with curry had moderately good textural scores but were lower than the above

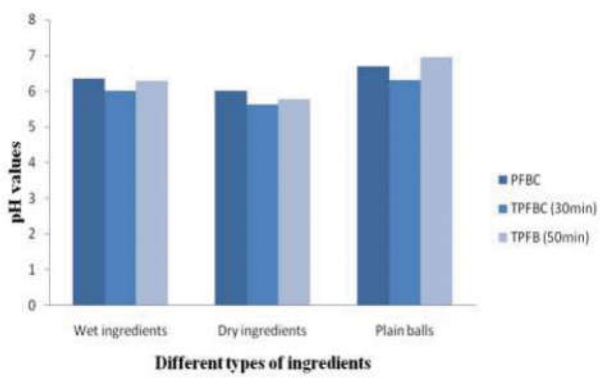

Fig. 4: pH of fish ball product with different types of ingredients

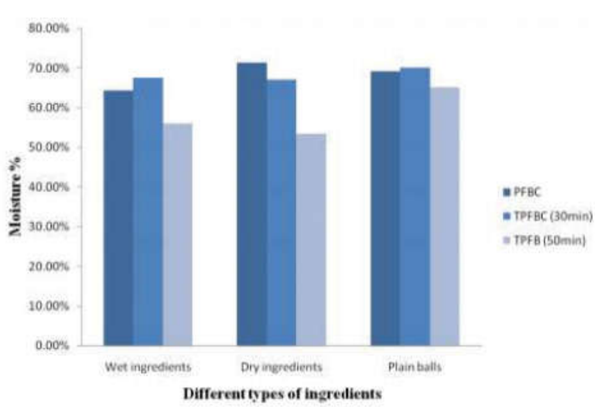

Fig. 5: Moisture content of fish ball product with different types of ingredients

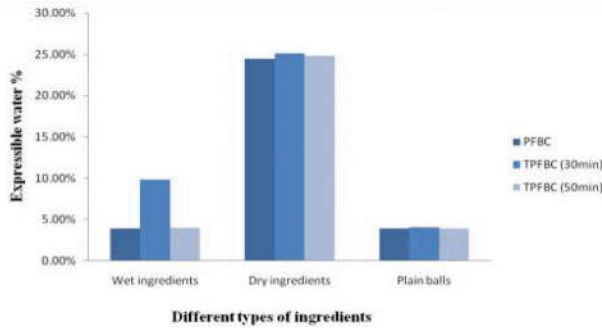

Fig. 6: Expressible water percentage of fish ball product with different types of ingredients

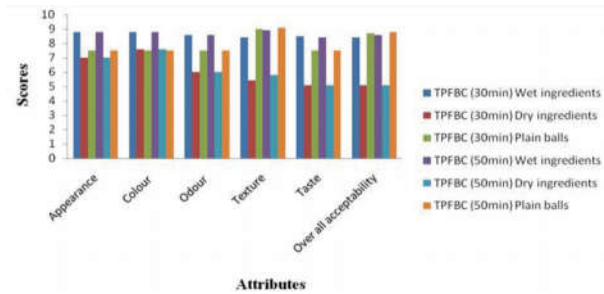

Fig. 7: Organoleptic evaluation of fish ball product with different types of ingredients

three samples. The textural scores of fish balls of the above four types were lower than the fish balls steamed. Hence the all fish balls of the above types can be used for manufacture and sale bye the industry depending upon the choice of consumer in respect to textural scores. Plain fish balls can be improved further with respect to other quality characteristic like taste and color by addition of oleoresins and natural red color capsicum in the fish ball paste instead of the curry paste ingredients. Although wet ingredients incorporated fish balls in curry had lower textural values, it was liked by the panelists as they preferred soft texture to rubbery ones.

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