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Preservation of Farmed Carp (*Naini*) Fish by Salting Followed by Drying and it's Quality Evaluation

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Abstract

Salting and drying of fish was studied for preservation of *Naini* fish. Quality evaluation was done to study the shelf life. *Naini* fish was procured from Regional Agricultural Rearch station, Tarahara, Sunsari, Nepal. Three different treatment temperature (RT, 4°C and 10°C), different brine of salt concentration (4%, 8%, 12% and 16%) and four different brine treatment times (6, 12, 18, 24 hours) were optimized in this study. Sensorically, at RT (26°C) in brine of 12% salt concentration for 12 hours, at 4°C in brine of 16% salt concentration for 24 hours and at 10°C in brine of 16% salt concentration for 18 hours were optimized for *Naini* fish preservation. Peroxide values of these three best samples were evaluated for quality (shelf life) upto three months at 1.5 months interval. At the end of present study, peroxide value of all three samples were within acceptable limit (PV<8 meq O_2/kg). Peroxide value of sample treated at10°C in brine 16% salt concentration for 18 hours was found to be significantly least (5.46 meq O_2/kg). Thus for preservation and longer shelf life, treatment of *Naini* fish at 10°C in brine of 16% salt concentration for 18 hours and drying thereafter to about 8% moisture is the best condition.

Keywords: *Naini* fish; Salting and drying; Chemical composition; Sensory evaluation; Shelf life

Introduction

Fish is highly recommended diet particularly to the small children as well as to pregnant and breast feeding women to meet their protein requirement for better growth. Fish forms and excellent for human being because of many reasons like, easily digestible rich protein and less fatty with cholesterol free meat [1]. Fishes commodity is relatively a new investment in Nepal therefore this field is relatively in infant and under developing stage. Major part is pond fishes, where about 6735 hectare of village ponds, 12500 hectare wetland, 500 hectare lakes, 395000 hectare rivers and 1500 hectare reservoirs of water bodies have been exploited for fish production in Nepal but significantly in Terai region. There are around 186 fish species in Nepal, among them some catfish have high economical/ecosystem values as their taste, aboundances, fishing characters and growing habit [2].

Carp is one of the oldest domesticated species of fish for food. According to the FAO statistics of 2004 [3], production of farmed common carp was about 13% (3,387,918 tones) of the total global freshwater aquaculture production. Asia is the main producing region of the species with the majority of production consumed domestically. Carp are considered as delicacy in many countries throughout the world. They are tolerant to wide range of temperature, oxygen levels and salinities.

Naini (*Cirrhinus mrigala*), a carp, is one of the three major carp species cultivated widely in Southeast Asian countries. This species has long been important in polyculture with other native species, mainly in India. In addition, *Naini* has become an important component in the fish culture systems of Nepal, Bangladesh, Pakistan, Myanmar, the Lao People's Democratic Republic and Thailand. *Naini* has also been introduced into Sri Lanka, Vietnam, China, Mauritius, Japan, Malaysia, Philippines and the former USSR [4]. *Naini* is fast growing fish & therefore preferred for pisciculture. When cultured artificially *Naini* can grow to a great size. Rich in protein content as food [3].

There are 186 species of fish in Nepal. It has been reported that a total of 186 fish species are found in various water bodies in Nepal. They inhabit altitudes ranging from a few hundred metres above sea level to as high as 4000 metres. Three indigenous major carps (rohu-*Labeo rohita*, catla-*Catla catla* and Naini-*Cirrhinus mrigala*) are already included in the country's aquaculture production systems [2].

Preservation of fish in developing countries like Nepal is generally done by traditional method i.e., salting or drying; salting and drying or by salting, smoking and drying. The combination effect of salting, smoking and drying is more effective to extend the self- life. Preservation for a long term is generally done by freezing or canning but in developing country like Nepal is not possible due to expensive operations.

The principle aim of preservation is to delay, reduce or inhibit the spoilage. In case of fatty fish, the preservation may also aim at reducing or inhibiting oxidation and other undesirable changes in the fish oils, which are highly unsaturated and capable of going rancid at various stages of processing [5].

Materials and Methods

The study was conducted at Central Campus of Technology, Hattisar, Dharan during 2011-2012.

Fish

Fresh *Naini* fish weighing total of 6 kg, each around 30-40 g was purchased from Regional Agricultural Research Station, Tarahara,

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sunsari, Nepal. It was brought by keeping in a clean polythene bag within 20 minutes in the laboratory of Central Campus of Technology.

Methodology

Fish were dressed using knife and then gutted, fins were removed and washed with tap water. Brine solutions were made of 4%, 8%, 12% and 16% salt concentration and fish were dipped in this solutions which are kept at room temperature (at 26°C), at 4°C and at 10°C. These samples were drawn at 6 hours, 12 hours, 18 hours and 24 hours from this different temperature and were brought to dry in cabinet dryer.

The brined fishes were simply introduced into cabinet dryer of Central Campus of Technology. Preliminary drying was done at 45-50°C for about 1 hour to prevent from case hardening and then thermal treatment was done at 80-85°C for 1 hour to denature protein and final drying was done at 60°C to the final moisture content of the fish about 8%. The product obtained after drying were cooled and packed in clean PP (30µm) by heat sealing machine. The flow chart for the preparation of salted-dried fish is shown in figure 1.

Chemical analysis

Fresh fish was analyzed for moisture, crude protein, crude fat, ash, carbohydrate and peroxide value was determined for the final product. Moisture content was determined according to [6]. Crude protein content in the fresh fish was determined according to AOAC and Subba [6,7]; crude fat in the fresh fish as per AOAC and Subba [6,7]; ash content as per Subba [6]; carbohydrate content by difference and peroxide value for the final product as per Subba [6].

Sensory evaluation

The final products were evaluated for texture, flavor, color, taste and overall acceptance on 9 point hedonic rating test by a selected panel of 6 judges.

Statistical data analysis

The data were subjected to statistical analysis and the scores given by the panelist were analysed by Two-way Analysis of Variance (ANOVA) at 5% level of significance to determine whether the samples were significantly different from each other and also to determine which one is superior between them.

Results and Discussion

Chemical composition of fresh fish flesh

The fresh fish flesh taken from the fish (*Naini*) of Tarahara Farm was analysed in the laboratory for its chemical composition. The scientific name of the fish is *Cirrhinus mrigala*. The table 1 shows the chemical composition of fresh fish flesh.

Sensory analysis of salted dried fish

A nine point hedonic rating of the salted dried fish was carried out with 6 panelists. The sensory scores for optimization of concentration and time are given in table 2a-2e, table 3a-3e and table 4a-4e.

Sensory analysis of salted dried fish treated at RT (room temperature) for optimization of salt concentration in brine and time: The mean sensory scores for optimization of salt concentration in brine and time are given in table 2a-2e. The graphical representation for optimization of salt concentration at room temperature (26°C) for 6 hours is shown in figure 2a. The statistical analysis shows that there was no significant difference (p>0.05) between flavor, texture and taste

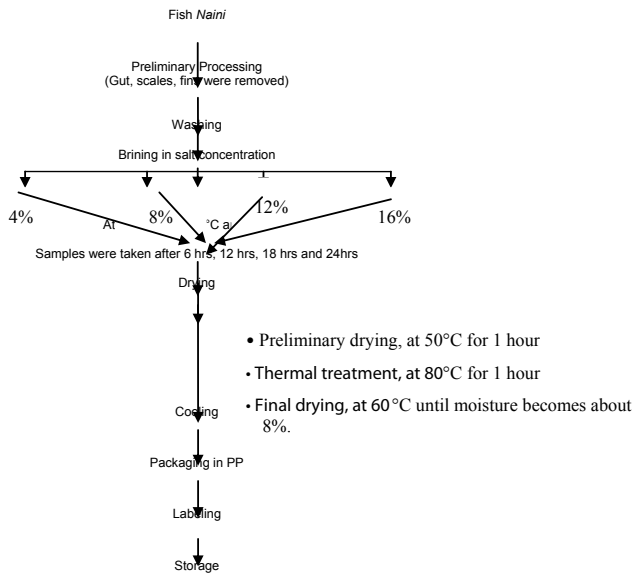


Figure 1: Flowchart for preparation of salted- dried fish.

Constituents	Value (%)
Moisture content	78.3(0.31)
Crude protein	17.4(0.41)
Crude fat	2.5(0.21)
Ash	1.6(0.13)
Carbohydrate	0

The values in the parenthesis give standard deviation of three replicates.

Table 1: The chemical composition of fresh fish flesh on wet basis.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	4.33^{a}	4.33^{a}	5.17^{a}	5^{a}	5.16^{a}
8	5^{b}	5.5^{b}	6^{b}	5.8^{b}	5.83^{b}
12	6.67^{c}	5.66^{b}	6.5^{b}	6^{bc}	6.5^{c}
16	7.33^{d}	6.5^{c}	7.5^{c}	6.33^{c}	7.33^{d}
LSD (P<0.05)	0.608	0.476	0.605	0.498	0.53

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 2a: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at room temperature (26°C) for 6 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.33^{a}	5.17^{a}	5.33^{a}	5.33^{a}	5.66^{a}
8	6^{b}	6^{b}	6.33^{b}	5.50^{a}	7^{b}
12	7.83^{c}	7.33^{c}	8.50^{c}	7.17^{b}	8^{c}
16	6.66^{d}	6.83^{c}	7^{d}	6.33^{c}	7^{b}
LSD (P<0.05)	0.53	0.686	0.498	0.622	0.317

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 2b: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at room temperature (26°C) for 12 hours.

for sample dipped in brine of 8 and 12% salt concentration in 6 hr but significantly different (p<0.05) for 4 and 16% salt concentration in 6 hr. No significant difference was found for taste in 6 hr for brine of 12% and 16% salt concentration whereas brine of 4% and 16% salt concentration were significantly different. The color and overall acceptance (OA)

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.33[a]	5.16[a]	5.5[a]	5.5[a]	5.5[a]
8	6[a]	6.16[b]	6.17[b]	6.5[b]	6[b]
12	7.66[c]	7[c]	7.67[c]	7[c]	7.33[b]
16	6.5[d]	6.33[b]	6.83[d]	6[d]	6.66[c]
LSD (P<0.05)	0.481	0.467	0.658	0.389	0.576

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 2c: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at room temperature (26°C) for 18 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.5a	5.66[a]	5.66[a]	5.67[a]	5.6[a]
8	6.16[b]	6.33[b]	6.16[a]	6[b]	6.16[b]
12	7.5[c]	7.16[c]	7.5[b]	7[c]	7.5[c]
16	6.66[d]	7[c]	6.83[c]	6.5[d]	6.33[b]
LSD (P<0.05)	0.498	0.425	0.53	0.463	0.565

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 2d: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at room temperature (26°C) for 24 hours.

Time (hr)	Color	Flavor	Texture	Taste	OA
6	6.67[a]	5.66[a]	6.5[a]	6[a]	6.5a
12	8.16[b]	7.5[b]	8.33[b]	7.16[b]	8.16[b]
18	7.66[bc]	7[c]	7.67[c]	7[b]	7.33[c]
24	7.5[c]	7.16[bc]	7.5[c]	7[b]	7.5[c]
LSD (P<0.05)	0.594	0.43	0.686	0.40	0.594

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 2e: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of time at room temperature (26°C) for brine of 12% salt concentration.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	4.5[a]	5.33[a]	4.66[a]	5.33[a]	5[a]
8	5.16[b]	5.83[a]	5.66[b]	5.5[a]	5.5[b]
12	6.66[c]	6.16[a]	6[b]	6.33[b]	6.16[c]
16	6.83[c]	6.83[b]	6.83[c]	6.16[b]	6.83[d]
LSD (P<0.05)	0.425	0.514	0.36	0.467	0.425

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 3a: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 4°C for 6 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.5[a]	5.5[a]	5.66[a]	5.8[a]	5.66[a]
8	5.83[a]	6.16[b]	6.33[b]	6[a]	6.16[a]
12	6.66[b]	6.5[b]	7[c]	7.16[b]	7[b]
16	7.66[c]	7.5[c]	7.66[d]	5.66[a]	7.66[c]
LSD (P<0.05)	0.343	0.55	0.565	0.565	0.514

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 3b: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 4°C for 12 hours.

scores for all concentrations were significantly different in 6 hr, hence, significantly higher scores were awarded for sample treated with brine of 16% salt concentration in 6 hr at RT.

The sample treated in brine of 16% concentration for 6 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8]. The sample dipped in brine of 16% salt concentration was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample. Higher the salt concentration, the greater the replacement of water [9].

The graphical representation for optimization of salt concentration in brine at room temperature (26°C) for 12 hours is shown in figure 2b. The statistical analysis shows that there was significant difference ($p<0.05$) between color, flavor, texture and overall acceptance for sample dipped in brine of 4%, 8%, 12% and 16% salt concentrations

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.66[a]	5.67[a]	5.83[a]	5.5[a]	5.83[a]
8	5.83[a]	6[a]	6.5[b]	6.17[b]	6.33[b]
12	6.5[b]	6.66[b]	7[c]	6.67[b]	6.83[c]
16	7.83[c]	7.83[c]	7.82[d]	7.33[c]	7.83[d]
LSD (P<0.05)	0.53	0.481	0.383	0.608	0.463

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 3c: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 4°C for 18 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	6[a]	5.67[a]	5.83[a]	5.66[a]	5.66[a]
8	6.33[b]	6.33[b]	6.33[b]	6.16[b]	6.33[b]
12	7.33[c]	7[c]	7.33[c]	6.83[c]	7.16[c]
16	8.33[d]	7.66[d]	8.5[d]	7.5[d]	8.33[d]
LSD (P<0.05)	0.317	0.518	0.389	0.481	0.383

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 3d: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 4°C for 24 hours.

Time (hrs)	Color	Flavor	Texture	Taste	OA
6	6.83[a]	6.83[a]	6.83[a]	6.17[a]	6.83[a]
12	7.66[b]	7.5[b]	7.66[b]	5.67[a]	7.67[b]
18	7.83[b]	7.83[b]	7.82[b]	7.33[b]	7.83[b]
24	8.33[c]	7.66[b]	8.5[c]	7.5[b]	8.33[c]
LSD (P<0.05)	0.389	0.425	0.481	0.608	0.449

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 3e: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of time at 4°C for brine of 16% salt concentration.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	4.67[a]	5.16[a]	4.83[a]	5.16[a]	5[a]
8	5.5[b]	5.66[b]	5.66[b]	5.5[a]	5.66[b]
12	6.5[c]	6[b]	6[b]	6.33[b]	6.33[c]
16	6.83[c]	6.33[b]	7[c]	6.5[b]	7[d]
LSD (P<0.05)	0.619	0.481	0.481	0.481	0.41

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 4a: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 10°C for 6 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.66^{a}	5.67^{a}	5.83^{a}	5.67^{a}	5.83^{a}
8	6^{a}	6.33^{b}	6.33^{b}	6^{a}	6^{a}
12	6.83^{b}	6.66^{b}	7^{c}	6.83^{b}	7^{b}
16	7.83^{c}	7.33^{c}	7.83^{d}	7^{b}	8^{c}
LSD (P<0.05)	0.343	0.534	0.449	0.619	0.251

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 4b: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 10°C for 12 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.83^{a}	5.5^{a}	5.83^{a}	5.5^{a}	5.83^{a}
8	6.16^{b}	6^{a}	6.5^{b}	6.16^{b}	6.33^{b}
12	7.16^{c}	6.66^{b}	7.33^{c}	6.66^{b}	7.16^{c}
16	8.16^{d}	7.66^{c}	8.5^{d}	7.83^{c}	8.16^{d}
LSD (P<0.05)	0.317	0.59	0.383	0.576	0.383

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 4c: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 4°C for 18 hours.

Concentration (%)	Color	Flavor	Texture	Taste	OA
4	5.83^{a}	5.5^{a}	6^{a}	5.66^{a}	5.83^{a}
8	6.33^{b}	6.33^{b}	6.5^{b}	6.16^{a}	6.16^{a}
12	8.16^{c}	7.5^{c}	8.16^{c}	7.5^{c}	7.83^{b}
16	7.16^{d}	6.83^{b}	7.33^{d}	6.66^{a}	7^{c}
LSD (P<0.05)	0.383	0.591	0.41	0.502	0.361

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

Table 4d: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of salt concentration in brine at 10°C for 24 hours.

Time (hr)	Color	Flavor	Texture	Taste	OA
6	6.83^{a}	6.33^{a}	7^{a}	6.5^{a}	7^{a}
12	7.83^{b}	7.33^{bc}	7.83^{b}	7^{a}	8^{b}
18	8.16^{b}	7.66^{b}	8.5^{b}	8^{b}	8.16^{b}
24	7.16^{a}	6.83^{ac}	7.33^{ab}	6.67^{a}	7^{a}
LSD (P<0.05)	0.485	0.561	0.58	0.605	0.251

The values are the mean of six panelist score. The values having same superscript in a column did not differ significantly at 5% level of significance.

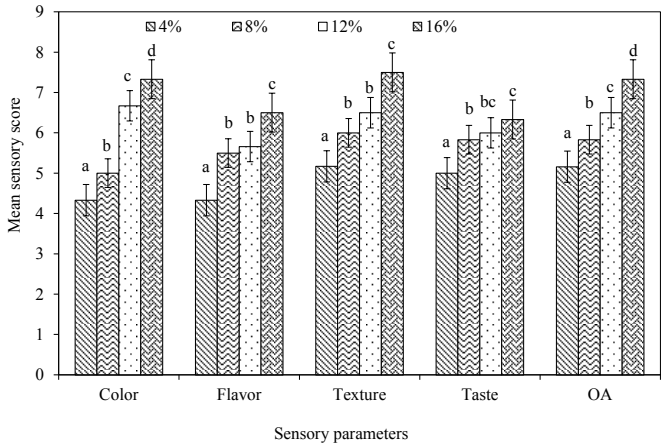
Table 4e: Summary of the statistical test showing the difference between the treatments and within the variates for optimization of time at 10°C for brine of 16% salt concentration.

in 12 hr but no significantly different (p>0.05) in taste for 4% and 8 % salt concentration in 12 hr. There was significantly different in taste between the samples dipped in brine of 12% and 16% salt concentration. Similarly significantly highest score was awarded for 12% for all sensory parameters.

The sample treated in brine of 12% concentration for 12 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin (Burgess *et al.*, 1967). The sample dipped in brine of 12% salt concentration was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample.

The graphical representation for optimization of salt concentration in brine at room temperature (26°C) for 18 hours is shown in figure 2c. The statistical analysis shows that there was no significant difference (p>0.05) between flavor for sample treated with brine of 8% and 16% salt concentration and OA for 4% and 8% salt concentration but significantly different (p<0.05) for 12% and 16% salt concentration in 18 hr. Significant difference was found for color and texture in all the concentration. Significantly highest score was awarded for sample treated in brine of 12% salt concentration for all the sensory parameters.

The sample treated in brine of 12% concentration for 18 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8]. The sample dipped in brine of 12% salt concentration was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample. Optimum salt penetration



(Similar alphabet above the bars indicates not significantly different (p>0.05). The error bars show the standard deviation.)

Figure 2a: Optimization of salt concentration in brine at room temperature (26°C) for 6 hours.

Figure 2a: Optimization of salt concentration in brine at room temperature (26°C) for 6 hours.

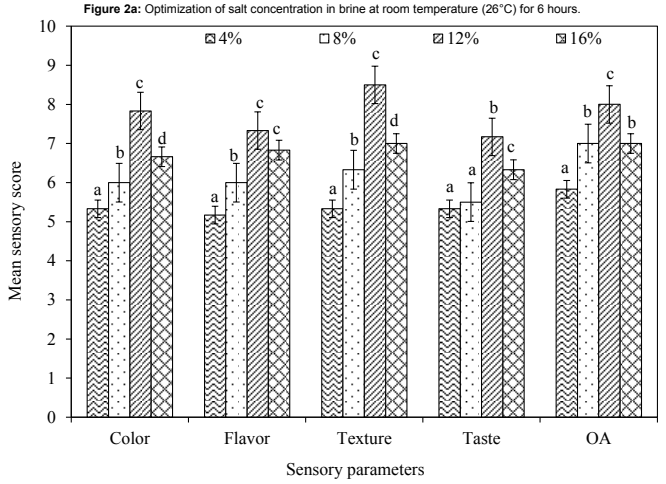


Figure 2b: Optimization of salt concentration in brine at room temperature (26°C) for 12 hours.

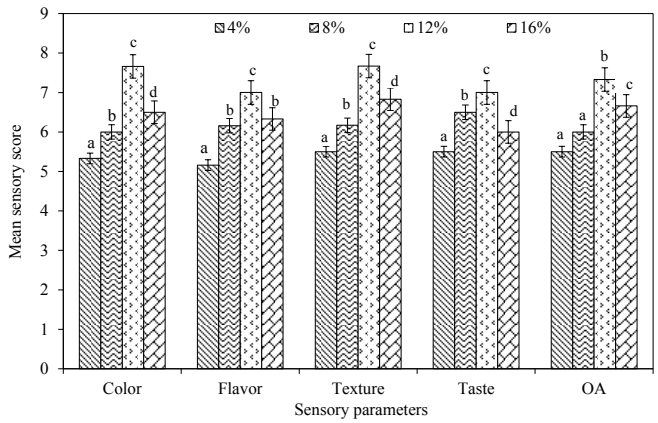


Figure 2c: Optimization of salt concentration in brine at room temperature (26°C) for 18 hours.

in fish product improves the texture and makes the final product appreciated by consumers [10].

The graphical representation for optimization of salt concentration in brine at room temperature (26°C) for 24 hours is shown in figure 2d. The statistical analysis shows that there was no significant difference ($p>0.05$) between flavor for sample treated with brine of 12% and 16% salt concentration but significantly different ($p<0.05$) for 4% and 8 % salt concentration in 24 hr. There was no significant difference in texture for 4% and 8% salt concentration but significantly different for 12% and 16% salt concentration. No significant difference was found for OA in 8% and 16% salt concentration but significantly different for 4% and 12% salt concentration. Significant difference was found for color and taste for all the concentration. Significantly highest score was awarded for 12% salt concentration for all the sensory parameters.

The sample treated in brine of 12% concentration for 24 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8]. The sample dipped in brine of 12% salt concentration was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample.

The graphical representation for optimization of time at room temperature (26°C) for brine of 12% salt concentration is shown in figure 3e. The statistical analysis showed that there was no significant difference ($p>0.05$) between texture for 18 and 24 hr; between flavor for 18 and 24 hr, 12 and 24 hr; between color for 18 and 24 hr, 12 and 18 hr; between taste for 12, 18 and 24 hr and between OA for 18 and 24 hr but significantly different ($p<0.05$) for others. Significant higher score was awarded for all the sensory parameters for 12 hrs.

The sample treated in brine of 12% concentration for 12 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8]. The sample dipped in brine of 12% salt concentration for 12 hr was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample.

Sensory analysis of salted dried fish treated at 4°C for optimization of salt concentration in brine and time

The mean sensory scores for optimization of salt concentration and time are given in table 3a-3e. The graphical representation for optimization of brine concentration at 4°C for 6 hours is shown in figure 3a. The statistical analysis shows that there was no significant difference ($p>0.05$) between color and taste for sample treated with brine of 12% and 16% salt concentration in 6 hr. There was no significant different between flavor for 4%, 8%, and12% but significantly different for 16% salt concentration. No significant different was found between textures for 8% and 12% salt concentration but significantly different for 4% and 16% salt concentration. Significant difference was found between color for 4% and 8% but no significant difference in taste. Significant difference was found between OA for all the concentration. Significantly highest score was awarded for 16% salt concentration for color, flavor, texture and OA.

The sample treated in brine of 16% concentration for 6 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped

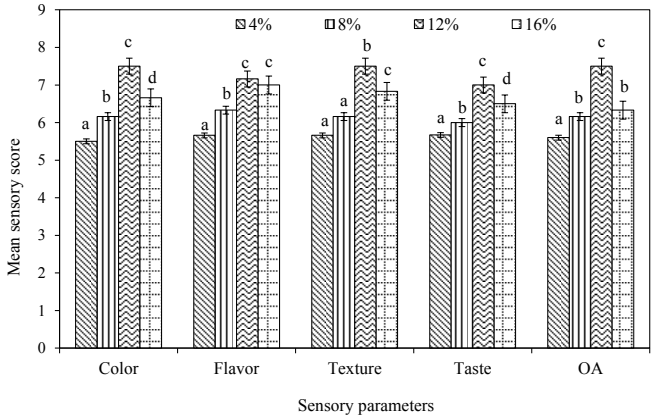


Figure 2d: Optimization of salt concentration in brine at room temperature (26°C) for 24 hours.

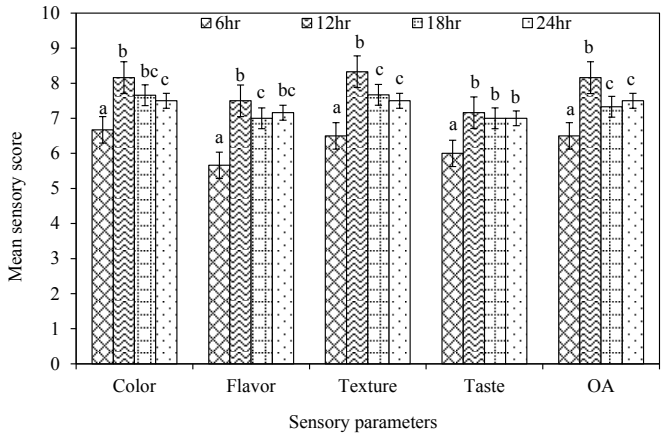


Figure 2e: Optimization of time at room temperature (26°C) for 12% brine concentration.

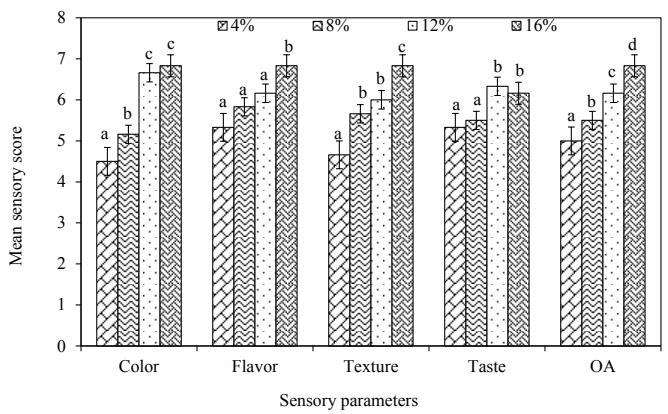


Figure 3a: Optimization of salt concentration in brine at 4°C for 6 hours.

period this dries on the outer surface and produces the familiar glossy skin [8]. The sample dipped in brine of 16% salt concentration for 6 hr was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample. The rate of salt uptake is very important with regard to weight change, water holding capacity (WHC) and even the taste of the final product [11].

The graphical representation for optimization of salt concentration in brine at 4°C for 12 hours is shown in figure 3b. The statistical analysis showed that there was no significant difference ($p>0.05$) between color, taste and OA for sample treated with brine of 4% and 8% salt concentration in 12 hr but significantly different ($p<0.05$) for 12% and 16% salt concentration in 12 hr. There was no significant different between flavor for 8% and 12% salt concentration but significantly different for 4% and 8%. Significant difference was found between texture for all the concentration. Significantly highest score was awarded for 16% salt concentration for color, flavor, texture and OA.

The graphical representation for optimization of salt concentration in brine at 4°C for 18 hours is shown in figure 3c. The statistical analysis showed that there was no significant difference ($p>0.05$) between color and flavor for sample treated with brine of 4% and 8% salt concentration in 18 hr but significantly different ($p<0.05$) for 12% and 16% concentration. No significant difference was found for taste for 8% and 12% salt concentration but significantly different for 4% and 16%. Significant different was found between texture and OA for all the concentration. Significantly highest score was awarded for 16% salt concentration in 18 hr.

The graphical representation for optimization of salt concentration in brine at 4°C for 24 hours is shown in figure 3d. The statistical analysis showed that there was significant difference ($p<0.05$) between color, flavor, texture, and overall acceptance for all the concentration. The mean score awarded highest for 16% salt concentration for all the sensory parameters.

The graphical representation for optimization of time at 4°C for brine of 16% salt concentration is shown in Figure 3e. The statistical analysis shows that there was no significant difference ($p>0.05$) was found between color, texture and OA for 12 hr and 18 hr but significantly different for others. There was no significant difference between taste for 18 hr and 24 hr, 6 hr and 12 hr. No significantly different was found between flavor for 12 hr, 18 hr and 24 hr, but significant different for 6 hr and others. The mean score awarded highest for color, texture, taste and OA for 24 hr.

The sample treated in brine of 16% concentration for 24 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8]. The sample dipped in brine of 16% salt concentration for 24

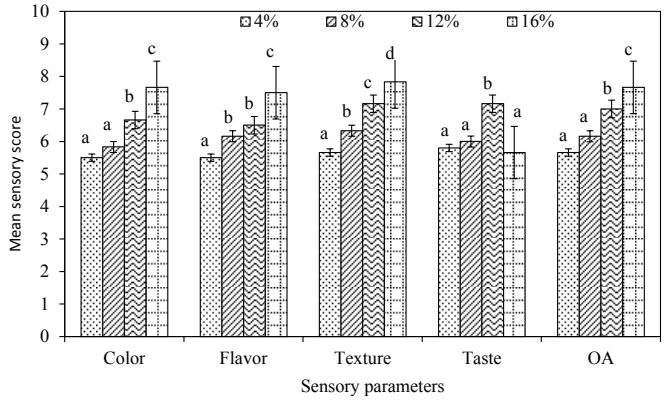


Figure 3b: Optimization of salt concentration in brine at 4°C for 12 hours.

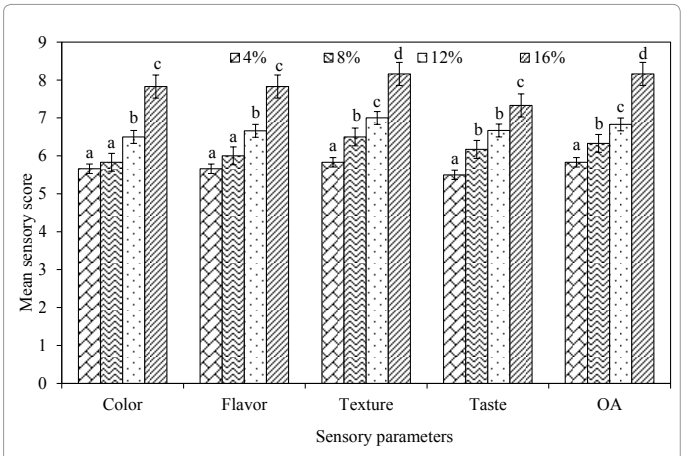


Figure 3c: Optimization of salt concentration in brine at 4°C for 18 hours.

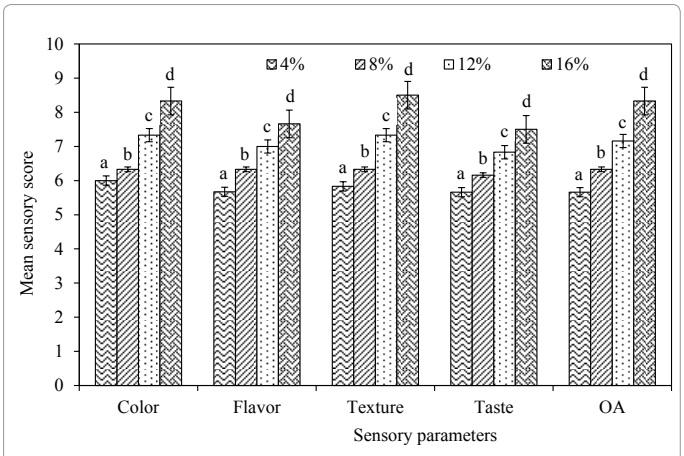


Figure 3d: Optimization of salt concentration in brine at 4°C for 24 hours.

hr was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample. The rate of salt uptake is very important with regard to weight change, water holding capacity (WHC) and even the taste of the final product [11].

Sensory analysis of salted dried fish treated at 10°C for optimization of concentration and time

The mean sensory scores for optimization of salt concentration in brine and time are given in table 4a-4e. The graphical representation for optimization of salt concentration in brine at 10°C for 6 hours is shown in figure 4a. The statistical analysis shows that there was no significant difference ($p>0.05$) between color for sample treated with brine of 12% and 16% salt concentration in 6 hr but significantly different ($p<0.05$) for 4% and 8%. No significantly difference was found between flavor for 8%, 12% and 16% salt concentration but significantly different for 4%. There was no significant different between taste for 4% and 8%, 12% and 16%; between texture for 8% and 12% but significantly different for others. There was significant difference between OA for all the concentration. The mean score awarded highest for 16% salt concentration for all the sensory parameters.

The sample treated in brine of 16% salt concentration for 6 hr achieved good texture. High salt concentration causes small protein loss by the osmotic effect of the appropriate salt and gives appreciable texture [12]. The sample treated in brine of 12% concentration for 24 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8].

The graphical representation for optimization of salt concentration in brine at 10°C for 12 hours is shown in figure 4b. The statistical analysis shows that there was no significant difference ($p>0.05$) between color

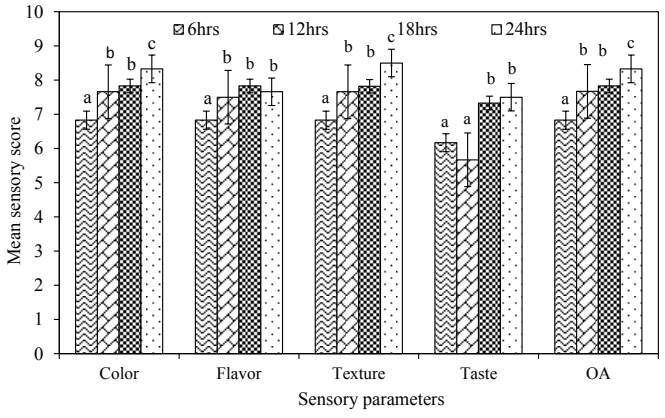


Figure 3e: Optimization of time at 4°C for brine of 16% salt concentration

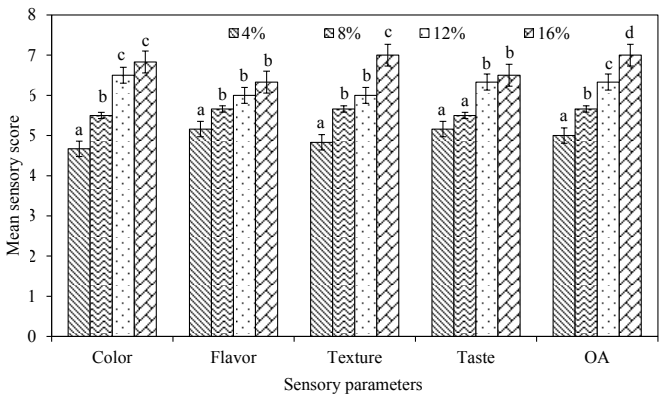


Figure 4a: Optimization of salt concentration in brine at 10°C for 6 hours.

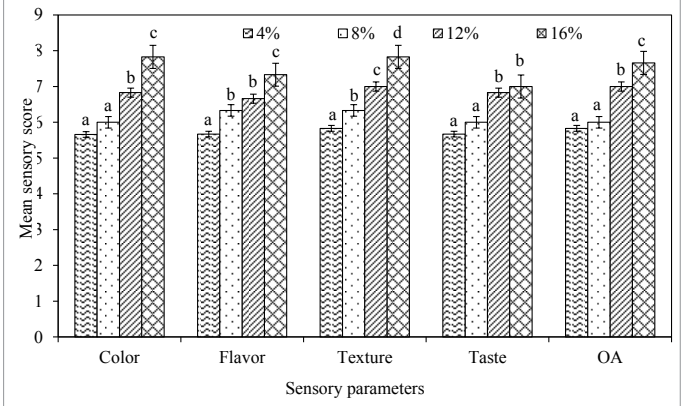


Figure 4b: Optimization of salt concentration in brine at 10°C for 12 hours.

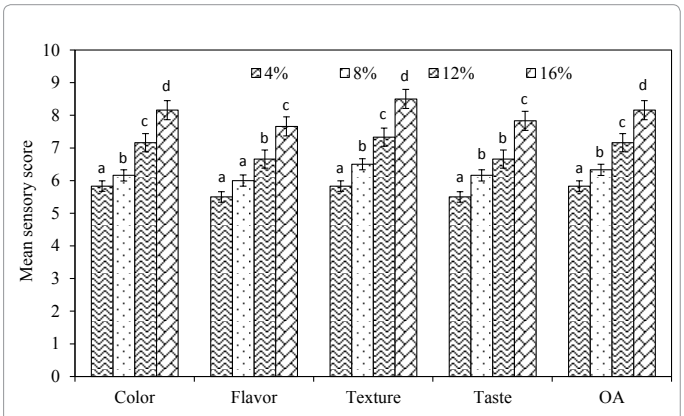


Figure 4c: Optimization of salt concentration in brine at 10°C for 18 hours.

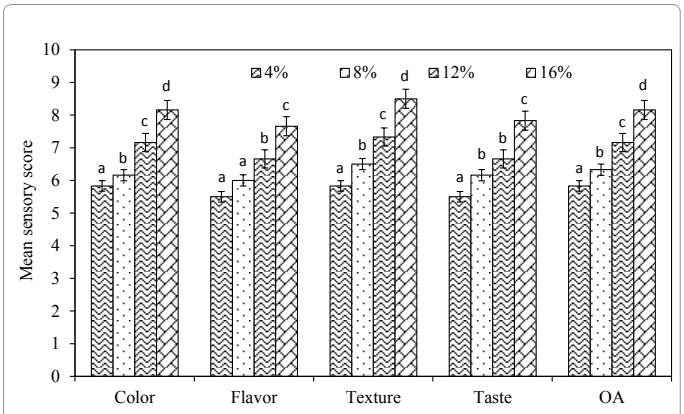


Figure 4d: Optimization of salt concentration in brine at 10°C for 24 hours.

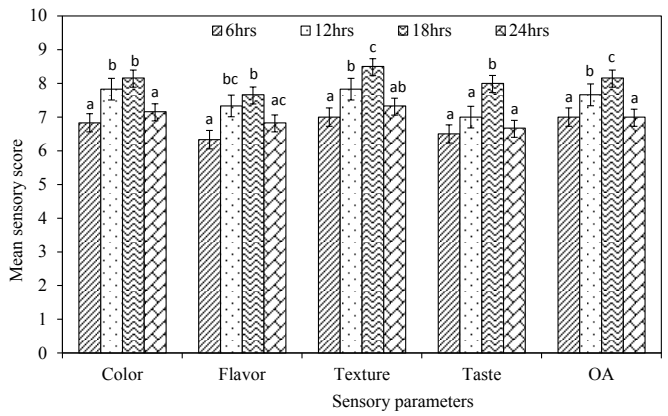


Figure 4e: Optimization of time at 10°C for 16% brine concentration.

and OA for 4% and 8% salt concentration but significantly different ($p<0.05$) for 12% and 16%. No significantly different between flavor for 8% and 12% but significant different for 4% and 16%. There was no significant different between taste for 4% and 8%, 12% and 16% but significantly different for others. Significantly highest score was awarded for 16% salt concentration in 12 hr.

The graphical representation for optimization of brine concentration at 10°C for 18 hours is shown in figure 4c. The statistical analysis showed that there was significant difference ($p<0.05$) between color, texture and OA for all the concentration. No significant difference was found between flavor for 4% and % salt concentration but significant different was found for others. There was no significant different between taste for 8% and 12% but significant different for others.

The graphical representation for optimization of salt concentration in brine at 10°C for 24 hours is shown in figure 4d. The statistical analysis showed that there was significant difference ($p<0.05$) between color and texture for all the concentration. There was significant different between taste and OA for 4% and 8% salt concentration but significantly different for 12% and 16%. No significant difference was found between flavor for 8% and 16% but significantly different for others. The mean score awarded highest for 12% salt concentration for all the sensory parameters.

The sample dipped in brine of 12% salt concentration for 24 hr was accepted in terms of texture and flavor by panelists may be due to the sufficient salt penetration into the sample. The rate of salt uptake is very important with regard to weight change, water holding capacity (WHC) and even the taste of the final product [11]. The sample treated in brine of 12% concentration for 24 hr had higher score for color. More preference to this sample by panelists may be due to the satisfactory glossy skin. Protein dissolves in brine of suitable concentration to give a sticky solution, during the dripped period this dries on the outer surface and produces the familiar glossy skin [8].

The graphical representation for optimization of time at 10°C for brine of 16% salt concentration is shown in figure 4e. The statistical analysis showed that there was no significant difference ($p>0.05$) between color for 6 hr and 24 hr, 12 hr and 18 hr but significantly different for others. There was no significant different between flavor for 6 hr and 24 hr, 12 hr and 18 hr but significantly different for others. No significant different was found between texture for 6 hr and 24 hr, 12 hr and 24 hr but significantly different for others. There was no significant different between taste for 6 hr, 12 hr and 24 hr, between OA for 6 hr and 24 hr but significantly different for others. Significantly higher score was awarded for 18 hr for texture, taste and OA.

Shelf life study of product

The products were packed in packaging material polypropylene (PP). The shelf life analysis was carried out on the basis of chemical analysis. Increase in peroxide value (PV) was evaluated to study shelf life. The graphical representation between peroxide value and storage time (months) is shown in figure 5.

The statistical analysis showed that there was significant difference between samples for PV with storage days. In the beginning, the PV of best three samples were found to be 2.89, 1.85 and 2.32 for samples treated RT, 4°C and 10°C respectively. Highest PV in zero months was found for RT followed by 10°C and lowest for 4°C. This might be due to the lower temperature in case of 4°C.

PV was found to be increased in linear fashion and the increase in PV was significantly different between the samples. At the end of storage days in present study, PV of sample treated at RT was 6.55, at 4°C were 6.97 and at 10°C were 5.46. The values at the end of 3 months were within acceptable limit. According to Lawson [13], the product having peroxide value above 8meq/kg was not acceptable. Thus we can concluded that the sample treated at 10°C in brine of 16% salt concentration dipped for 18 hours was best in terms of PV. The lower PV in this case might be due to optimum storage temperature and brine treatment time which favored proper salt penetration that enhance shelf life.

Conclusions

Various conclusions were drawn from the present research. Optimum conditions for preservation of *Naini* fish by salting and drying was found to be at 10°C treated in brine of 16% salt concentration for 18 hours. Alternative preservation conditions of *Naini* fish can be done at room temperature (26°C) in brine of 12% salt concentration for 12 hours and at 4°C in brine of 16% salt concentration for 24 hours treatment. The peroxide value for best three samples packed in PP were within acceptable limit (PV<8 meq O_2/kg) in three months so quality of fish at three months of storage was found to be acceptable. Hence by these treatments shelf life were extended satisfactorily for three months. As per PV, the best preservation technology is the treatment at 10°C in brine of 16% salt concentration for 18 hours. Treatment at 10°C in brine of 16% salt concentration for 18 hours is most economic way of preservation.

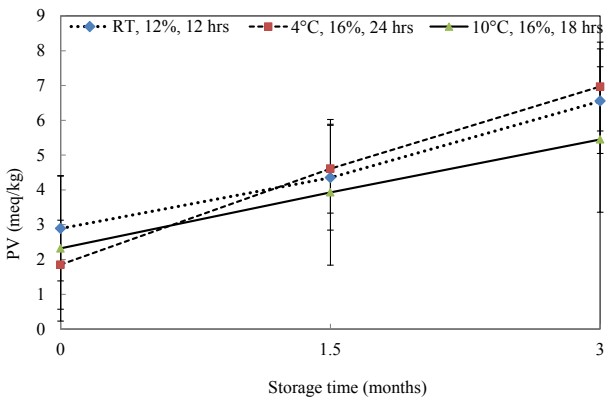


Figure 5: Change in peroxide value of salted-dried fish packed in PP.

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