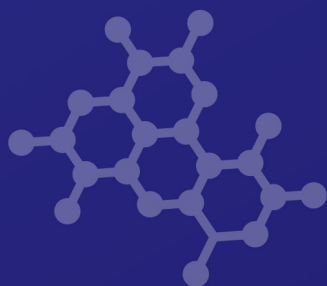




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Optimization of Vacuum Marination Process, Maximizing the Flavor Infusion of Sole Fish

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ABSTRACT

The major problem facing the fish processing industry is reducing the marination process time and increasing the uptake of marinade. Previously, a marination bath has been utilized for this purpose with different combinations of acid and salt, which causes physiochemical changes in fish texture. The vacuum marination method seems to be a good way to solve this problem. In this study, the effect of the vacuum marination process was studied on the marination of sole fish. Two varieties of fish (fresh and frozen) and three levels of time (10, 20 and 30 minutes) were studied for their effect on marinade uptake. The marinade was used in the ratio of 1.2:10 spices to meat, respectively. Fresh samples were weighted, vacuum packed, and stored at 4–7 °C, whereas frozen samples were stored at -20 °C for 24 hours prior to marination and thawed at room temperature. After marination, percentage uptake, retention, and cooking loss of the marinade were calculated. It was concluded from the yield of marinated products that about 80% of marination takes place in the first 10 minutes of the process. After 10–20 minutes, there was no significant difference ($p > 0.05$), and only 1–2% of the marinade was consumed. The frozen samples show significantly ($p \leq 0.05$) higher yields and marinade uptake. After marination, the samples were stored at 0–4 °C and fried in vegetable oil until the center reached 70 °C. Cooking loss for this process was non-significant for both varieties of fish as it depends on the water-holding capacity of the meat, which remains the same for both cases. The use of vacuum marination reduced the marination time significantly from 4–6 hours to 10 minutes, and marinade uptake was improved. This process can be used as an alternative to traditional marination techniques.

INTRODUCTION

Most of the people in Pakistan like to eat fish in its fresh and firm form after frying, grilling, salting and marination. The methods like salting, smoking, and fermenting are not much used for fish products in Pakistan. A large quantity of fish is usually consumed in winter season all over Pakistan. The products of fish marinades are obtained from different kind of whole fish, through different process like frozen products, salted products and fresh fish. The meat for these products is prepared through different acid and salt concentration to develop a better taste in the products (Szymczak *et al.*, 2012). At industrial level, it is important to reduce the marinating time to obtain the same final characteristics of pH, aw, and sensorial attributes. This can be done by increasing either the salt and acid contents of the marinating solution or the marinating solution fish ratio, or by agitation during the marinating process (Hewage *et al.*, 2022). Thawing after freezing changes both the substance and the moisture of meat tissue. Moisture content as a quality trademark in meat can be assessed in a few different ways, including trickle misfortune, defrost misfortune, cooking loss, water restricting limit and aggregate dampness content. In any case, since the techniques used to decide dampness misfortune and changes in meat are not set by a global standard, usually hard to straightforwardly look at and reach inferences from considers in the writing that have utilized diverse strategies for such purposes (Sampels, 2015). Marination

plays a vital role in meat processing at different level of processing as marination helps in decreasing microbial and enzymes load. Marination also provides a value addition in fish (Jia *et al.*, 2022.). Marinated fish fillets are preserved by the concurrent action of natural acids, for example, acetic acid and salt. The joined additive activity keeps the development of pathogenic microscopic organisms and most deterioration microorganisms. The aims of this research were to determine the effect of subfreezing and thawing conditions on the marination uptake and the salt and acid, immersion time, and sensorial characteristics during the marinating process of sole fish. Fresh and frozen samples were investigated for uptake time of marinade within same conditions.

MATERIAL AND METHODS

Sample and Marinade Preparation

Sole fish used with maximum acceptance was procured from local market of Faisalabad after sensory evaluation by the team of experts. After washing and cutting the whole fish, its skin was removed for better marination. Removed skin helps in up taking maximum marinade, reduce cooking time, good color, and sensory characteristics. After size reduction, the fish pieces were packed in polythene bags for both frozen and fresh samples. Fresh samples were weighted and vacuumed packed until the marination starts and kept at 4–7 °C. Samples were weighted before freezing and each sample was separately frozen (-20 °C) in vacuumed packaging

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(Leygonie *et al.*, 2012). All samples of fish both fresh and frozen were independently labeled before marination so that their identification remains same throughout the process of marination. Primary ingredients in marinade were salt, chili, phosphate, and water. The concentration of each ingredient in the marinade formulation can vary according to the product desired. The major concern of this study was to investigate the salt uptake that enriches the taste of product and sodium tri poly phosphate which increases the water holding capacity, marinade uptake and retention of marinade. The marinade used in this experiment was 1.2:10 water and meat respectively (Nakazawa & Okazaki *et al.*, 2020).

Vacuum Marination of samples

The reverse process of freezing is called thawing. The process used in this experiment was still air thawing at ambient conditions. The samples were placed on the mesh so that the water released from the meat did not interact with the fish. Marinating was performed for period of 10, 20, 30 minutes interval for both fresh and frozen sample at same ambient condition. The process of marination was performed each time at 8 rpm and 5 in Hg. After each sample treatment, sample were weighted separately as tagged and the final weight of sample was recorded.

Analysis and Calculations

Fresh and frozen samples were weighted after marination to find the percentage uptake of each sample

$$\% \text{ Uptake} = (\text{final weight}(Y) - \text{initial weight}(X) / \text{initial weight } X) \times 100$$

The samples were stored after marination at 4 °C for 24 hours to calculate the marinade retention

$$\text{Marinade retention } (\%) = (\text{Weight after marination} - \text{Weight after 24 hours} / \text{Weight after marination}) \times 100$$

After 24 hours the marinated fish was cooked until the center of the sample reached to 75 °C

$$\text{Cooking Loss } (\%) = ((\text{Wt. precook} - \text{Wt. post cook}) / \text{Wt. precook}) \times 100$$

To find the overall efficiency of the process was calculated as final yield

$$\text{Yield } (\%) = (\text{Wt. post cook} / \text{Wt. pre marination}) \times 100$$

RESULTS

Effect of Fish Variety and Marination Time on the Marinade Uptake (%)

Two varieties of fish (V, fresh and frozen) and three levels of time (T, 10, 20 and 30 minutes) were studied for their effect on marinade uptake. The results obtained by the data showed that the effect of T, V and interaction V*T was highly significant. The effect of T on marinade uptake was significant showing that in first 10 minutes

Table 1: Effect of Variety and Marination Time on the Percentage Marinade Uptake

Marinade Uptake					
Source	DF	SS	Mean Square	F Value	Pr > F
V	1	17.7488	17.748	112.37	0.0001**
T	2	1.723	0.867	5.45	0.0207*
V*T	2	37.369	18.687	118.29	0.0001**
Error	14	11.2619	0.8044		
Corrected Total	17	51.8992			

Table 2: Comparison of Means of Marinade Uptake (%) Under the Effect of Fish Variety and Time

Marinade Uptake			
VARIETY		T (Mean)	
	1	2	3
1	83.300±1.538	90.367±1.057	84.900±0.700
2	92.567±1.257	86.123±0.646	90.150±0.489

marinade uptake is maximum later, it is in very small amount (< 5%MU).

Effect of Fish Variety and Marination Time on

Marinade Retention

Two varieties of fish (V, fresh and frozen) and three levels of time (T, 10, 20 and 30 minutes) were studied for their effect on marinade retention. The results obtained

Table 3: Effect of V and T on Marinade Retention (%)

Marinade Retention					
Source	DF	SS	Mean Square	F Value	Pr > F
V	1	52.776	52.779	65.81	0.0001**
T	2	1.565	0.787	0.98	0.4050NS
V*T	2	144.388	72.197	90.04	0.0001**

Error	14	12.00	0.8571		
Corrected Total	17	12.00			

Table 4: Comparison of Means (%) of Marinade Retention Under the Effect of Interaction V And T

Marinade Retention			
VARITY		T	
	1	2	3
1	1.487±0.078	5.370±0.607	2.716±0.088
2	6.013±0.676	3.326±0.138	6.185±0.318

by the data showed that the effects of V and interaction V*T were highly significant. The effect of T on marinade retention was non-significant.

Two varieties of fish (V, fresh and frozen) and three levels of time (T, 10, 20 and 30 minutes) were studied for their effect on marinade yield. The results obtained by the data showed that the effect of V and T was non-significant. The effect of V*T on marinade yield was highly significant.

Effect of Variety and Time on The Percentage Yield of Process

Table 5: Effect of Fish Variety and Time on the Overall Yield (%) of the Process

Yield					
Source	DF	SS	Mean Square	F Value	Pr > F
V	1	0.379	0.3189	0.67	0.427NS
T	2	1.563	0.787	1.66	0.239 NS
V*T	2	22.275	11.117	23.60	0.0001**
Error	14	18.6211	1.3300		
Corrected Total	17	20.16			

Table 6: Comparison of Mean Percentage Yield Under the Interactions of V And T

Yield			
VARITY		T	
	1	2	3
1	95.167±0.919	93.200±0.487	94.867±0.377
2	93.267±0.997	96.077±0.389	93.033±0.836

Effect of Fish Variety and Marination Time on the Cooking Loss

The results obtained by the data showed that the effects of

V and interaction V*T were highly significant. The effect of T on cooking loss was also highly significant showing that in first 10 minutes marinade uptake is maximum.

Table 7: Effect of Fish Variety and Time on the Cooking Loss (%)

Cooking Loss					
Source	DF	SS	Mean Square	F Value	Pr > F
V	1	0.749	0.749	18.28	0.001**
T	2	1.658	0.829	20.40	0.0001**
V*T	2	15.428	7.729	190.43	0.0001**
Error	14	4.4657	0.3189		
Corrected Total	17	7.099			

Table 8: Comparison of Mean Percentage of Cooking Loss Under the Effect of Variety and Time

Cooking Loss			
VARITY		T	
	1	2	3
1	10.467±0.157	11.567±0.152	9.277±0.173
2	11.657±0.123	9.417±0.325	11.453±0.259

DISCUSSION

It was concluded that about 80% of marination take place in first 10 minutes of marination at the condition that were provided in this experiment. Time plays an important role in explain the uptake of marinade. Time from 10-20 minutes plays very minute role in up taking time of marinade. As this experiment were conducted to minimize the process optimization of meat marination while considering next ten minutes are not beneficial for 1-2 % of marination process. Rather than increasing time experiment should be conducted on marination ratio or vacuum control as this experiment were taken out at 5 inches of Hg (Moadab *et al.*, 2018). Increasing rpm during vacuum marination above 8 results in damaging the meat fillets as during these experiments 2 fillets were broken. The stirrer design was also very important meat can stick and marination of these samples were seems stopped about one and other which result in reduced uptake. Agitation can increase the temperature of process temperature that can directly affect the marinade retention of meat. It was concluded increasing temperature above certain range resulted in decrease of marinade retention and meat started releasing the marinade. After marination of meat samples meat store at 0-4 °C retained the maximum marinade. Cooking loss were seeming not different from each other as cooking loss depend upon the water holding capacity of the meat in both cases the thawing losses were same. The above result concluded that using vacuum marination reduced the time marination but after freezing and thawing the process time decreased significantly (Jia *et al.*, 2022b). The parameter of vacuum marinade ratio rpm and time plays a significant role. According to this study marinade uptake were improved in the marinating solution, the water contents were decreased after thawing and the average thawing loss during all these experiments were remain 2.22% and while comparing with the fresh sample these thawing loss help to gain more marinade uptake during vacuumed marination process and the texture and water content of the sole fillet were reliant on the levels of salt and acid that the fish tissue takes.

CONCLUSION

The results reduced the time of marination to only 10 minutes as compared to traditional 3 hour with increased tenderness better and enriched taste. The core purpose of marination is to absorb the flavors of the marinade for the food like meat, to tenderize it. Polyphosphates changes the microstructure of the meat by solubilizing salt soluble proteins. In addition, polyphosphates improve tenderness of chicken breast, reduce cooking and frying losses.

The frozen samples showed significant improvement in marinade uptake and its retention due to broken structure of cell during freezing and thawing which helped the meat to gain more marinade. The vacuum marination process seems to be a future promising approach which can reduce the time of marination as well as provide the good quality meat due to no use of chemicals and additives to enhance the uptake and retention.

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