JRIFST

www.journals.rifst.ac.ir
Journal of Research and Innovation
in Food Science and Technology

Volume 10, Issue 2, September 2021, Pages 199-216
Document Type: Extended Abstract
DOI: 10.22101/JRIFST.2021.274948.1232

Extended Abstract

Investigating the Possibility of Extraction of khandal Extract by Percolation Method and its Application in Marinated White Indian Shrimp Fillet

Samar Sadeghii[1], Nargess Mooraki[2*], Masoud Honarvar[3]

1- MSc. Graduate, Department of Food Science and engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran
2- Associated Professor, Department of Fisheries Science, Faculty of Marine Sciences and Technology, North Tehran Branch, Islamic Azad University, Tehran, Iran
* Corresponding author (n_mooraki@iau-tnb.ac.ir)
3- Associated Professor, Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran

Recieved: 2021.03.22; **Accepted:** 2021.09.08

Abstract

Shrimp meat is very rich in protein and has more protein than meat of slaughtered livestock and fish and has a short shelf life due to its high perishability. Therefore, plant extracts can be used to maintain product quality for a long time. In the present study, the aim was to optimize the extraction of Mandab plant by percolation method in terms of solvent type factors, solvent ratio, time and finally the application of the optimal extract according to the total phenolic composition and inhibition of 2,2-diphenyl-1-picrylhydrazyl free radicals to prepare marinade from Indian white shrimp (*Penaeus indicus*) and its shelf life at refrigerator temperature and changes in physicochemical properties (including: pH, acidity, thiobarbituric acid, total volatile basic nitrogen, water holding capacity, water activity, sensory evaluation, acid-salt taste measurement and texture test) product using It was SPSS method. The results showed that the optimal extract was obtained using ethanol solvent in 36 h and a volume of 7 mL. The lowest amount of TVB-N was observed in day 20 of the experiment and with 30٪ of the extract, the lowest amount of TBA was observed in the control sample. Changes in pH and acidity without significant differences between treatments had a decreasing trend compared to the control sample during the storage period. WHC had a decreasing trend compared to the control and aw samples without significant differences between treatments, more than the control sample.

Keywords: Antioxidant activity, Indian white shrimp, Khandal, Marinade, Percolation

Introduction

Seafood has short shelf life due to its high perishability; therefore, various methods are needed to maintain product quality. Use of plant extracts with bioactive compounds and preparing marinades as effective treatments with the potential to increase the duration of food storage and inhibiting oxidation is convenient (Erkan, Ulusoy, & Tosun, 2011; Falguera, Quintero, Jiménez, Muñoz, & Ibarz, 2011). These effects are based on decreasing pH, water activity, and increasing salt content, and ionic strength, thereby reducing bacterial and enzymatic activity (Behera, Madathil, Verma, & Pathak, 2020) *Eruca sativa* belongs Brassicaceae family, commonly known as Arugula and to be reached in variety of phenolic compounds. In the present study, the aim was to optimize extraction by percolation method from Arugula by considering solvent

type, solvent consumption ratio, and time as factors, finally Preparing Indian white shrimp (*Penaeus indicus*) marinade and study of its storage time at 4±1 ºC by evaluating chemical, physical and sensory properties of the product.

Materials and methods

Sample preparation

Eruca sativa, freshly prepared, after cleaning drying and fully grinding used for extraction, sea caught shrimps (Persian Gulf) were also freshly prepared in ice and after filleting, they were used to prepare marinades.

Extraction

extraction by percolation method was performed by optimizing the combination of three factors i.e., solvent type, time and ratio of solvent consumption using Box Behenken routine and considering the total phenolic compounds (TPC) and inhibitory power of DPPH free radicals. The ability of SERF to scavenge free radicals was performed using the synthetic free radical compound DPPH, according to (Stojičević, Stanisavljević, Veličković, Veljković, & Lazić, 2008). TPC was determined using the Folin-Ciocalteu assay according to (Parejo *et al*., 2002).

Marinade preparation

Washed shrimp fillets were separated in four groups, and each immersed in marinated mixture for 3 h at 4 °C. Marinate mixture contained 100 mL distilled water, 7 mL Acetic acid 5%, 20g sodium chloride, and Arugula extract; the mixture being sterilized in autoclave. The treatments(T) and control(C) groups immersed in different bowls regard to the volume of Arugula extract as T_1: contained 10%, T_2: contained 20%, T_3: contained 30% and C: contained 0% extract. Then the marinades kept at 4±1 ºC for 20 days, and at 10 days interval the samples evaluated for chemical, physical and sensory properties.

Quality Evaluation

pH was measured by pH meter according to (Kavitha & Modi, 2007). Acidity measured through titration (Jongberg, Tørngren, Gunvig, Skibsted, & Lund, 2013). Total volatile basic Nitrogen (TVB-N), were measured according to AOAC (2000), by use of titration by boric acid. Thiobarbituric acid (TBA) was measured by use of spectrophotometer and absorbance at 538 nm, the results expressed as mg of malondialdehyde per kg of sample (Kirk & Sawyer, 1991). Water holding capacity (WHC) was measured according to the method of Rørå, Regost, & Lampe (2003). Water activity (aW) was measured by use of Hygrometer according to (Chen, Liu, & Chen, 2002). Sensory evaluation was done through five-point hedonic procedure with participation of 45 panelist.

Statistical Analysis

Experimental design was performed using Design Expert 7 using response surface methodology and Box-Behnken routine with 15 runs. The solvent types defined as an ordinal factor due to their dielectric constant by use of Dummy coding method (Table 1). Statistical analysis was done by use of SPSS V20. In cases where the data had a normal distribution, one-way ANOVA and Duncan's post-hoc at significance level of (P<0.05) and in cases of non-normal distribution, Kruskal-Wallis test was used. Chi-square test was used to compare sensory data.

Table 1. Factors used in optimizing extraction of *Eruca sativa* through percolation method

Factor	Code	Min.	Max.
Solvent type	A	*	*
Time (hour)	B	24	72
Solvent volume(ml)	C	5	20

* Solvent type: (1) water (2) methanol (3) ethanol

Results and discussion

Measuring the inhibitory power of DPPH free radicals, showed that the proposed model for the three factors was quadratic equation, but one-way ANOVA showed that none of the factors had a significant effect ($P \geq 0.05$). Measuring the content of TPC showed that the proposed model was quadratic equation and results of one-way ANOVA revealed that all three factors have a significant effect ($P<0.05$) on the content of total phenolic compounds in extraction process. Optimal extraction condition based on measuring the content of TPC (mg GA/mL) 0.4281 and the free radical scavenging power of DPPH equal to 0.9960% in a volume of 5.33 mL of ethanol over a period of 45.40 h with a desirability of 0.999 was calculated.

Studies show that products containing plant origin compounds, due to their richness in bioactive and phytochemicals can maintain and improve human health (Elsagh *et al*., 2015). Mooraki, Honarvar, & Salami (2021), extracted antioxidant compounds from Arugula by use of microwave and it was revealed that the use of 5 mL water as solvent due to having the highest dielectric constant compared to other solvents and duration of 30 min and power of 256 watts was the optimized condition. The amount of TPC extracted was reported to be 0.2155 (mg GA/mL), which was almost half of the amount extracted in the present study, so it is concluded that in the case of this plant, ethanol with a lower dielectric constant but for a longer duration and without the need of applying energy to the cell wall, had a better effect on the extraction of antioxidant compounds.

According to Table (2), WHC level was significantly different between the samples ($P<0.05$), reversely pH and acidity were not significantly different among the samples ($P \geq 0.05$). In the same pattern, the content of TVB-N and TBA were compared among the groups and the results are presented in Table (3).

Table 2. WHC and a_w in experimental groups

Experimental Group	a_w (%)	WHC (%)
CD_0	0.91±0.06	$80±1.28^{d}$
T_1D_0	0.94±0.06	$63.3±2.61^{i}$
T_2D_0	0.95±0.01	$68.4±0.88^{g}$
T_3D_0	0.94±0.05	$70.8±3.57^{f}$
CD_{10}	0.93±0.04	$94.8±1.5^{b}$
T_1D_{10}	0.93±0.05	$75.4±0.8^{e}$
T_2D_{10}	0.94±0.01	$81.3±1.8^{d}$
T_3D_{10}	0.93±0.02	$85.6±1.6^{c}$
CD_{20}	0.93±0.02	$97.8±1.3^{a}$
T_1D_{20}	0.93±0.02	$66.2±1.9^{h}$
T_2D_{20}	0.93±0.02	$71.7±1.57^{f}$
T_3D_{20}	0.93±0.02	$75.2±1.6^{e}$

*: superscripts show the significant differences ($P<0.05$) in each column between the experimental groups.

Table 3. pH, acidity, TVB-N and TBARs in experimental groups

Experimental Group	pH	Acidity (%)	TVBN (%)	$TBAR_S$ (%)
CD_0	7.55±0.84	0.01±0.01	$32.43±2.2^{b}$	0.02±0.01
T_1D_0	7.25±0.55	0.02±0.01	$25.13±2.5^{d}$	0.01±0.01
T_2D_0	7.02±0.23	0.02±0.00	$24.13±2.2^{d}$	0.01±0.01
T_3D_0	6.92±0.67	0.01±0.01	$22.19±2.6^{e}$	0.01±0.01
CD_{10}	7.5±0.46	0.02±0.00	$36.06±2.2^{a}$	0.04±0.01
T_1D_{10}	7.39±0.14	0.02±0.01	$20.78±2.4^{f}$	0.03±0.00
T_2D_{10}	7.35±0.27	0.02±0.01	$19.95±2.5^{f}$	0.02±0.06
T_3D_{10}	7.30±0.40	0.02±0.01	$18.35±2.3^{fg}$	0.02±0.01
CD_{20}	7.20±0.65	0.02±0.00	$29.14±2.9^{c}$	0.05±0.01
T_1D_{20}	7.15±0.55	0.02±0.00	$19.10±2.3^{f}$	0.03±0.02
T_2D_{20}	7.10±0.75	0.02±0.01	$18.34±2.4^{g}$	0.04±0.03
T_3D_{20}	6.85±1.01	0.02±0.01	$16.87±2.7^{h}$	0.04±0.01

*: superscripts show the significant differences ($P<0.05$) in each column between the experimental groups.

In the present study, pH was significantly increased from the first to day 10 and then decrease until day 20. The observed trend, could be explained through production of volatile amines, in particular biogenic amines i.e., histidine, tyramine, cadaverine, which appears to occur more rapidly in shrimp than in fish meat which results in pH increment; However, after 20 days, the pH content decreases due to the production of organic acids and possibly a decrease in volatile amines. WHC increased significantly in the control group after 20 days, but in treated marinades it increased after 10 days of storage. This process can be due to the impact of temperature changes on production time, enzymatic and bacterial decomposition and cell damage during the storage time which, reduced solubility of proteins and their denaturation which lead to reduced WHC.

a_w, remained unchanged over time in the treated and control samples. Variations between all samples are more than the allowable range of 0.1-0.8, which is necessary to be considered if industrial and commercial production of such a product wants to be implemented. TVB-N results showed a significant decrease during the storage time and the control group showed a higher amount compared to treatments. The reason can be attributed to the use of extract, as it can partially prevent enzymatic and bacterial proteolysis and prevent the production of biogenic amino acids.

The amount of TBA increased without significant differences between the experimental groups during storage time. These changes can be due to the interaction between malondialdehyde and amines, nucleosides and nucleic acids, phospholipid amino acids, proteins, which are formed at the end of lipid oxidation. However, since this increase was not significant, it can be considered that the use of Arugula extract was effective in preventing oxidation. Regard to the sensory evaluations, on the first day of the experiment, odor and mouthfeel factors were not significantly different in marinated and control samples ($P \geq 0.05$), but appearance, taste, texture and color were significantly different ($P<0.05$); on day 10^{th}, the appearance, color and smell of the product had a significant difference ($P<0.05$) among the groups. Due to the considerations of the probable bacterial contamination, the tests of oral sensation and taste on day 10, and also the whole sensory evaluation on day 20, were omitted. In general, the presence of Arugula extract improved the overall acceptance of the product at 20 and 30 percent of addition to marinades.

Conclusions

According to the results, it was found that that the optimal extract was obtained using ethanol solvent in 45.40 h and a volume of 5.33 mL in percolation process. Application of ethanol solvent due to its dielectric constant can be effective in extracting antioxidant compounds from *Eruca sativa* leaves. Extract application in different concentrations had no effect on pH, acidity, a_w and TBARs indices, but in terms of WHC, TVB-N and sensory properties significant changes were observed. It was found that adding 30% of extract to marinade, can maintain the chemical quality of the product properly compared to other groups. Regarding to the slight bitter taste of the extract, it can be used to improve the sensory properties of fishery products and increase its share in the Iranian diet, which is less inclined to consume these types of proteins.

References

AOAC, H. W. (2000). International A: Official Methods of Analysis of the AOAC International. *The Association: Arlington County, VA, USA*.

Behera, S. S., Madathil, D., Verma, S. K., & Pathak, N. (2020). Seafood marination-A review. *International Archive of Applied Sciences and Technology*, *11*(3), 165-168. doi:https://doi.org/10.15515/iaast.0976-4828.11.3.165168

Chen, W., Liu, D., & Chen, M. (2002). Effects of high level of sucrose on the moisture content, water activity, protein denaturation and sensory properties in Chinese-style pork jerky. *Asian-Australasian Journal of Animal Sciences, 15*(4), 585-590. doi:https://doi.org/10.5713/ajas.2002.585

Elsagh, M., Fartookzadeh, M. R., Kamalinejad, M., Anushiravani, M., Feizi, A., Behbahani, F. A., . . . Adibi, P. (2015). Efficacy of the Malva sylvestris L. flowers aqueous extract for functional constipation: A placebo-controlled trial. *Complementary therapies in clinical practice, 21*(2), 105-111. doi:https://doi.org/10.1016/j.ctcp.2015.02.003

Erkan, N., Ulusoy, Ş., & Tosun, Ş. Y. (2011). Effect of combined application of plant extract and vacuum packaged treatment on the quality of hot smoked rainbow trout. *Journal für Verbraucherschutz und Lebensmittelsicherheit, 6*(4), 419-426. doi:https://doi.org/10.1007/s00003-011-0665-8

Falguera, V., Quintero, J. P., Jiménez, A., Muñoz, J. A., & Ibarz, A. (2011). Edible films and coatings: Structures, active functions and trends in their use. *Trends in Food Science & Technology, 22*(6), 292-303. doi:https://doi.org/10.1016/j.tifs.2011.02.004

Jongberg, S., Tørngren, M. A., Gunvig, A., Skibsted, L. H., & Lund, M. N. (2013). Effect of green tea or rosemary extract on protein oxidation in Bologna type sausages prepared from oxidatively stressed pork. *Meat science, 93*(3), 538-546. doi:https://doi.org/10.1016/j.meatsci.2012.11.005

Kavitha, S., & Modi, V. K. (2007). Effect of water activity and temperature on degradation of 5′-inosine monophosphate in a meat model system. *LWT - Food Science and Technology, 40*(7), 1280-1286. doi:https://doi.org/10.1016/j.lwt.2006.07.014

Kirk, S., & Sawyer, R. (1991). *Pearson's composition and analysis of foods*: Longman Group Ltd.

Mooraki, N., Honarvar, M., & Salami, P. (in press). Optimizing of Eruca sativa leaf (khandal) extraction by Microwave method and its application in marinated Huso huso (Beluga) fillet. *Journal of Food Technology and Nutrition*, -.

Parejo, I., Viladomat, F., Bastida, J., Rosas-Romero, A., Flerlage, N., Burillo, J., & Codina, C. (2002). Comparison between the radical scavenging activity and antioxidant activity of six distilled and nondistilled Mediterranean herbs and aromatic plants. *Journal of Agricultural and Food Chemistry, 50*(23), 6882-6890. doi:https://doi.org/10.1021/jf020540a

Rørå, A. M. B., Regost, C., & Lampe, J. (2003). Liquid holding capacity, texture and fatty acid profile of smoked fillets of Atlantic salmon fed diets containing fish oil or soybean oil. *Food Research International, 36*(3), 231-239. doi:https://doi.org/10.1016/S0963-9969(02)00141-2

Stojičević, S. S., Stanisavljević, I. T., Veličković, D. T., Veljković, V. B., & Lazić, M. L. (2008). Comparative screening of the anti-oxidant and antimicrobial activities of Sempervivum marmoreum L. extracts obtained by various extraction techniques. *Journal of the Serbian Chemical Society, 73*(6), 597-607. doi:https://doi.org/10.2298/JSC0806597S