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CONTENTS

Eurasian Journal of Food Science and Technology 2022; Vol: 6, Issue: 2, pp:69-75

Effect of Cold Storage on Color Properties and Antioxidant Capacity of Sous Vide Cooked Green Bean

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Abstract

Sous vide technique, a novel cooking technique, can preserve vegetables' quality more than traditional cooking techniques. However, there are limited studies on the changes in quality properties of the Sous vide cooked vegetables during cold storage. This study aimed to investigate the effects of cold storage on the color properties and antioxidant capacities of the Sous vide cooked green bean. The Sous vide cooked samples were stored in the refrigerator. The color properties, total phenolics content (TPC), and antioxidant activity (2,2-diphenyl-1-picrylhydrazylradical (DPPH) radical scavenging activity and ferric reducing antioxidant power (FRAP)) were determined at 0^{th}, 1^{st}, 3^{rd}, 5^{th}, and 10^{th} day of storage. The findings of this study revealed that the cold storage had a significant positive impact on the lightness (L*) value ($P<0.05$). However, it did not have a significant impact on the redness-greenness (a*) and yellowness-blueness (b)* values ($P>0.05$). After 10 days of storage, the TPC content of the green bean samples decreased from 534±34 mg 100 g^{-1} to 476±78 mg 100 g^{-1} ($P>0.05$). Moreover, the DPPH radical scavenging activity and FRAP decreased significantly from 2864±131 µmol 100 g^{-1} to 2209±247 µmol 100 g^{-1} and from 1278±103 µmol 100 g^{-1} to 1055±119 µmol 100 g^{-1}, respectively ($P<0.05$).

Keywords: Antioxidants, Cold storage, Cooking, Sous vide

Research article
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INTRODUCTION

The gastronomy and industry present new techniques in the preparation of foods to satisfy consumers' different needs. Sous vide is one of these new techniques (Roascio-Albistur and Gambar, 2018). In this technique, foods in vacuumed plastic pouches are cooked under the controlled conditions of temperature and time. Although Sous vide technique has been used by chefs since the 1970s, it has become well-known since the mid-2000s. This cooking technique has two main differences from the traditional cooking techniques: 1) foods are inserted in heat-stable vacuumed plastic pouches and then cooked 2) cooking temperature is precisely controlled (Baldwin, 2012).The application of Sous vide cooking technique comprises various foods such as meat and meat analogs (Gomez et al., 2019), pork ham (Jeong et al., 2018), lamb loins (Roldan et al., 2013), mackerel fillet (Cropotova et al., 2019), asparagus spears (Gonnella et al., 2018), Brassica vegetables (Florkiewicz et al., 2019), carrot and Brussel sprouts (Rinaldi et al., 2013).

Sous vide technique can preserve the nutritional values and sensorial properties of vegetables more than traditional cooking techniques. There is no contact between food and water. In this way, it prevents the loss of nutrients into cooking water (Armesto et al., 2017). After the application of Sous vide, foods can be rapidly chilled and stored in refrigerator for long term (10 days). Cold storage can have impact on the quality of vegetables, especially on color and antioxidant properties.

Epidemiological studies have revealed that the consumption of vegetables may be inversely correlated with chronic diseases. Green bean (*Phaseolus vulgaris L*. Fabaceae), an economically important vegetable, is used as fresh, canned and frozen. It is a good source of vitamin, mineral, and phenolic compounds. Its anti-glycaemic, hypo-lipidaemic, and antioxidant properties were reported (Abu-Reidah et al., 2013; Aquino-Bolanos et al., 2021).

In our knowledge, there are a lot of studies on the effect of the Sous vide cooking on the antioxidant capacities of vegetables (Armesto et al. 2019; Florkiewicz et al., 2018; Gonella et al., 2018, Kosewski et al., 2018; Lafarga et al., 2018). However, available studies on the effect of the cold storage on the antioxidant capacities of the Sous vide cooked vegetables are limited (Armesto et al., 2017). The aim of this study was to investigate the changes in the color properties and antioxidant capacity of the Sous vide cooked green bean during 10 days of storage in the refrigerator. The color properties, TPC, DPPH radical scavenging activity, and FRAP of the green samples were analyzed 0^{th}, 1^{st}, 3^{rd}, 5^{th} and 10^{th} days of storage.

MATERIAL and METHOD

Chemicals

Analytical grade chemicals and solvents were provided from Sigma-Aldrich Co. (Germany).

Material

The green beans were provided from a local market in Trabzon Province (Turkey). They were stored at 4°C overnight before the preparation for cooking.

Preparation of Green Beans

The green beans were washed and then dried with a towel. The dried beans were cut with a knife at 4-5 cm thick. A 100 g of the sliced beans were weighed and then placed in a vacuum bag. Food vacuum machine (Küchenpratic HP-6001, China) was used to close the bags.

Sous Vide Cooking

The vacuum bags were put in a water bath (GFL 1008, Germany). The samples were cooked at 90°C for 60 min. After the cooking, the samples were cooled.

Storage

The cooked samples were stored at 4° C for 10 days. Triplicate samples were prepared for each day. The samples were analyzed at 0^{th}, 1^{st}, 3^{rd}, 5^{th}, and 10^{th} day.

Color Properties

L*, a*, and b* values of the green bean samples were measured with a chromometer (Konica Minolta CR-400, Japan)

Preparation of Extracts

After the homogenization of the green bean samples, 0.5 g of the sample was weighed, and 5 ml of the methanol (80%) was added. The extraction was performed in an ultrasonic bath (Bandelin RK 103 H, Germany) for 30 min. The samples were centrifuged at 4000 rpm for 5 min (Centurion Scientific K2015R, United Kingdom). The extraction procedure was repeated. The combined supernatants were stored at -18 °C until the analysis

Total Phenolic Content

After 0.1 ml of the extract, 0.5 ml Folin Chiocalteu reagent, 0.4 ml sodium carbonate (1 M), and 4 ml water were mixed, then the solution was kept at dark for 1 hour. The absorbance of the solution was measured at 760 nm. The calibration curve was prepared with gallic acid. The TPC was expressed as mg gallic acid equivalent 100 g^{-1} dry matter.

DPPH Radical Scavenging Activity

0.1 ml extract and 1.9 ml DPPH reagent (60 µM) were mixed, and the solution was stored at dark for 1 hour. The absorbance was measured at 515 nm. The calibration curve was prepared with Trolox. The DPPH radical scavenging activity was expressed as µmol Trolox equivalent 100 g^{-1} dry matter.

FRAP Antioxidant Power

0.1 ml extract and 1.9 ml FRAP reagent were mixed, and the solution was stored at dark for 20 min. The absorbance was measured at 595 nm. The calibration curve was prepared with Trolox. The FRAP antioxidant power expressed as µmol Trolox equivalent 100 g^{-1} dry matter.

Statistical Analysis

Triplicate samples were analyzed at 0^{th}, 1^{st}, 3^{rd}, 5^{th}, and 10^{th} days of storage and at least duplicate analysis was carried out for each sample. Mean values and standard deviations were calculated. One-way variance analysis and Duncan test were applied to evaluate the differences among the samples ($P< 0.05$).

RESULTS and DISCUSSION

Table 1 presents the color properties of the green bean samples during the storage. The lightness (L*) value of the green bean samples increased significantly from 43.79 to 48.84 after 10 days of storage ($P<0.05$). Moreover, the yellowness-blueness (b*) value of the green bean samples increased from 19.95 to 23.51. However, no significant difference was found among the samples ($P> 0.05$). The redness-greenness (a*) value showed no significant difference during 10 days of storage as the b* value ($P> 0.05$).

Table 1. Color properties of the green bean samples during cold storage.

Properties	Day				
	0	1	3	5	10
L* value	43.79±1.12 [b]	45.81±1.56 [ab]	44.43±3.79 [ab]	44.87±3.10 [ab]	48.84±2.19 [a]
a* value	-3.27±0.99 [a]	-4.32±0.28 [a]	-3.41±0.94 [a]	-3.35±0.34 [a]	-3.59±0.72 [a]
b* value	19.95±2.66 [a]	21.63±0.37 [a]	20.64±2.36 [a]	21.22±1.33 [a]	23.51±2.69 [a]

Different letters in raw present significant difference (P< 0.05)

The color of green vegetables is mainly associated with chlorophyll (Rinaldi et al., 2013). The degradation of chlorophyll into its isomers leads to color changes.

A reduction in the greenness can be observed due to the degradation of chlorophyll during storage (Iborra-Bernard et al., 2013). No significant change in the greenness (a*) of the green bean samples was observed during 10 days of storage in the refrigerator. It could be concluded that the loss of chlorophyll was negligible during 10 days of storage.

Figure 1 presents the TPC of the green bean samples during the storage. The TPC values of the samples varied from 470±48 to 540±72 mg 100 g^{-1} (dry matter). The TPC of the green bean samples decreased from 534±34 to 476±78 mg 100 g^{-1} (dry matter). However, no significant difference was found among the samples with respect to the storage day (P> 0.05).

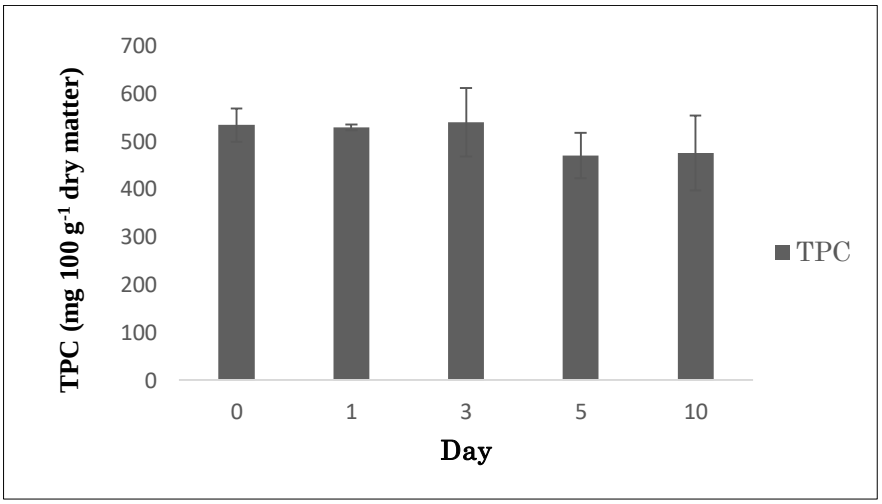

Figure 1. TPC of green bean samples

A reduction in the TPC could be related to the oxidation of phenolic compounds due to the disruption of cell wall during cooking and to the rearrangement of vegetable matrix during storage. Similar findings were reported for Brussels sprouts (Chiavaro et al., 2012) and kale (Armesto et al., 2017).

Figure 2 presents the DPPH radical scavenging activity of the green bean samples during the storage. The DPPH radical scavenging activity of the samples significantly decreased from 2864±131 to 2209±247 μmol 100 g^{-1} (dry matter) after 10 days of storage (P<0.05). However, no significant difference was found among 1st, 3rd, 5th, and 10th day of storage.

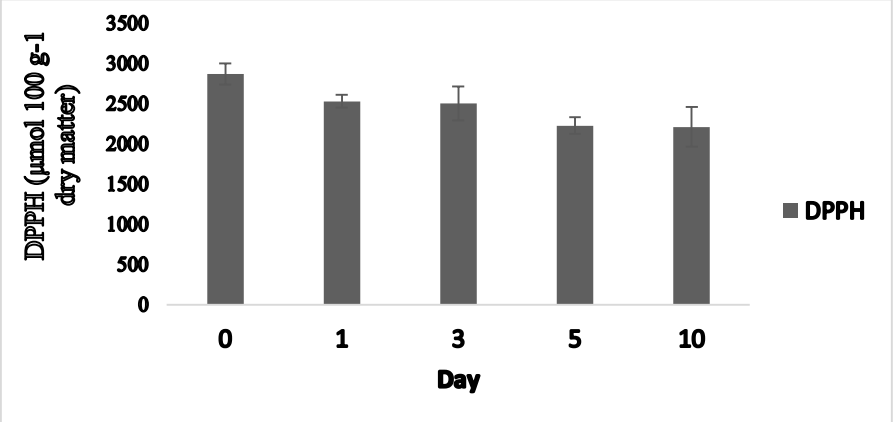

Figure 2. DPPH radical scavenging activity of green bean samples

Figure 3 presents the FRAP values of the green bean samples during the storage. The FRAP values of the samples varied from 941±70 to 1278±103 µmol 100 g^{-1} (dry matter). The FRAP values of the green been significantly decreased from 1278±103 to 1056±119 µmol 100 g^{-1} (dry matter) after 10 days of storage ($P<0.05$). However, no significant difference was found among 1st, 3rd, 5th, and 10th day of storage ($P> 0.05$).

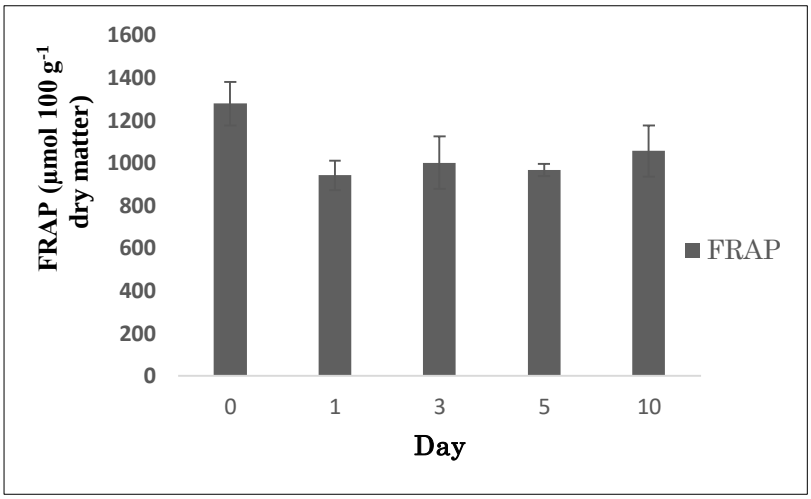

Figure 3. FRAP values of green bean samples

Green bean includes antioxidant compounds such as ascorbic acid, carotenoids, and phenolic compounds. Phenolic acids, flavonoids, and lignans as phenolic compounds were detected in green bean varieties (Abu- Reidah et al., 2012). After a significant reduction at 1st day of storage, the antioxidant capacity was retained until the end of storage. A reduction in the antioxidant capacities of the green bean could be related to the oxidation of antioxidant compounds (Armesto et al., 2017). Some studies supported our findings.

Chiavaro et al. (2012) reported a reduction in the FRAP of Brussels sprouts after 10 days of cold storage. Moreover, Armesto et al. (2017) determined a reduction in the DPPH radical scavenging activity of the kale samples after 7 days of cold storage.

CONCLUSION

The changes in the color properties, TPC, and antioxidant capacities of the Sous vide cooked green bean samples were determined during 10 days of storage in the refrigerator. The lightness of the green been increased during the cold storage. The TPC of the green bean seemed to be retained during the cold storage. However, the antioxidant capacity decreased at the first day and then retained. Further studies should focus on the changes in the antioxidant compounds of vegetables during the cold storage.

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Using Machine Learning Algorithms to Detect Milk Quality

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Abstract

Machine learning algorithms are used successfully in many sectors. The data formed by the development of digital technology are analyzed with machine learning algorithms and estimation, classification or clustering processes are carried out. Today, the food industry has a very important place and it will be very useful to follow the quality of the products produced and to determine in a short time. Milk is a product that people benefit from raw or processed. Milk is also a perishable product. Each gram milk with poor quality or structure can cause tons of milk to deteriorate, thus causing great financial losses. Millions of bacteria can form in spoiled milk in a very short time. In this way, if people consume milk or dairy products, situations that endanger human health may occur. In this study; A study was conducted in which milk quality was determined by machine learning algorithms. Seven features were used to determine milk quality. In the study, the Milk Quality dataset obtained from the open source Kaggle data repository was used. There are 1059 sample data in the data set. By using 7 attributes of milk samples, low, medium and high quality classification of milk was carried out. In the classification estimation phase, commonly used Neural Network (Neural Network: NN) and Adaptive Boosting (AdaBoost: AB) algorithms were used. Orange platform, which is open source and written in python, was used as the application platform. Orange is a platform with a widely used and see user interface. In the application phase, the results obtained with each algorithm were presented with visual graphics and comparisons were made. In the test phase, 100 milk data samples were used separately for each class in order to achieve a balanced learning. Random samples were selected from the data set for training. According to the results obtained; Classification accuracy (CA) success was achieved by 99.9% with AdaBoost algorithm and 95.4% with Neural Network algorithm. More successful results were obtained with the AdaBoost algorithm than the Neural Network algorithm.

Keywords: Machine learning, Neural network, AdaBoost, Smart decision system, Quality control, Food safety

Research article
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INTRODUCTION

With the developing technology, machine learning algorithms is used efficiently while performing quality control in the food industry (Xiao et al., 2019), in the mobile device system (Tahtacı and Canbay, 2020), while detecting malware and attacks on a computer system, server or any network (Singh et al., 2021), while diagnosing diseases in the health sector (Vrindavanam at al., 2021), while making control and error detection in the industry (Kanawaday and Sane, 2017), while making computer vision estimation (Çelik, 2022) while classifying products (Ozkan et al., 2021).

Milk is the most important food source and raw material for human health. Processed milk products (fermented) butter, yogurt, ayran, cheese (white cheese, string cheese, knitted cheese, cottage cheese, kashar etc.) (Küçük and Tapkı, 2020), many products such as kefir and kumiss are produced. With the development of the milk market, more demand comes to food producers. Therefore, improving the quality of fermented milk and reducing the rate of customer complaints has become the focus of food manufacturers.

Determining the milk quality by manual methods can result in high margin of error or loss of time. Since determining the quality of milk with only one feature will not give accurate results, it should be determined by taking into account many features. For this reason, it will be very efficient to analyze the milk data by an intelligent system using many features and to perform quality control.

Xiao et al. (2019) set up a random forest model, LR model, and AdaBoosting model and performed tests to find the most appropriate classification model. In the study, they showed that the color, aroma and taste of milk as attributes have the ability to recognize the quality of milk. According to the results obtained, the success rate was found to be 96.8%.

Sambasivam et al. (2020) estimated the Vitamin D Deficiency (VDD) rate, by using K-Nearest Neighbor (KNN), Decision Tree (DT), Random Forest (RF), AdaBoost (AB), Bagging Classifier (BC), ExtraTrees (ET), Stochastic Gradient Descent (SGD), Gradient Boosting (GB), Support Vector Machine (SVM), and Multi-Layer Perceptron (MLP) machine learning algorithms. According to the results they obtained, 96% correct results were obtained with the Random Forest algorithm.

Titova et al. (2018) performed food quality classification with Multi-layer perceptron (MLP) and AdaBoost algorithm. They used the pattern properties of potatoes as the data set.

Kumar et al. (2019) classified plant species by AdaBoost, k-NN, Decision Tree and Multilayer perceptron algorithms. They showed that leaves, flowers, fruits and seeds can be used while classifying. In the study, a success rate of 95.42% was achieved with machine learning algorithms.

Ricci et al. (2021) used x-rays to detect foreign materials on commercial products. In the study, they carried out a study to determine food safety and protect human health with the Neural Network algorithm, depending on the material density.

Keshavamurthy et al. (2019) proposed a food quality application using the method of identification and review with the OpenCV python library. Convolutional Neural Network (CNN) algorithm has been applied to perform fruit type recognition and quality detection tasks with quantitative data, precisely and reliably.

Vaishnav and Rao (2018) applied machine learning algorithms on the fruit image dataset using the Orange Data Mining Tool. In the study, they performed a comparative study to determine the algorithm with the highest classification accuracy and precision score. Attributes derived from the trained images were used in the decision making phase.

Thange et al. (2021) used the Orange Data Mining Tool to detect the relationship between case symptoms using the COVID-19 dataset shared in the Kaggle data storage and visually showed the results.

In this study, AdaBoost and Neural Network algorithms were applied on the Milk Quality dataset shared in Kaggle data storage and the success of estimating milk quality was compared. In the study, Orange Data Mining Tool was used as the application software interface. According to the results obtained, it was seen that the AdaBoost algorithm made a highly successful quality classification.

MATERIAL and METHOD

In this study, AdaBoost and Neural Network algorithms were applied on the Milk Quality dataset using the Orange Data Mining Tool.

Orange data mining tool

Many tools are available for visualization of data while performing the Machine Learning process. Much of model training adheres to scripting languages. However, with the use of Orange Data Mining Tool, data preprocessing, model training, testing and visualization can be performed with a single software (Vaishnav and Rao, 2018).

The Orange tool was developed by Janez Demsar et al. in 2013 using the Python programming language. Orange offers a hierarchically organized and visualized user-friendly interface of data mining and machine learning algorithm components. Interactive analysis and tests can be performed with its interface and visual components using Orange that contain more than 200 classes. The scripting requirement has been minimized with Orange. Orange has two main packages that are still under active development; scikit Learn (Pedregosa et al., 2011) and mlpy (Albanese et al., 2012) have been developed integrated (Demsar et al., 2013; Orange Data Mining, 2022).

Data management and preprocessing Component: Used for data input and output, data filtering and sampling, feature manipulation (discrete, persist, normalize, scaling, scoring) and feature selection.

Transform Component: It is used for merging, finding pivot point, grouping and preprocessing on data.

Data visualization Component: It is used to draw the scatter graph, temperature map and line graph of the results obtained from the application and the result.

Prediction Component: It is used to apply various supervised machine learning algorithms (Random Forest, AdaBoost, Neural Networks, Naive Bayes, SVM) on the data set.

Classification/Regression Component: It is used to perform ROC Analysis, Complexity matrix, Test and Score, Calibration operations on the data.

Unsupervised learning Component: It includes k-means and hierarchical clustering approaches; it is used in distance matrix, distance map, neighborhood and distance operations.

Figure 1 shows, the model designed on Orange. The application of AdaBoost and Neural Network machine learning algorithms used in the figure is shown. ROC analysis of performance achievements, Complexity matrix and table data can be obtained with Test-Score components.

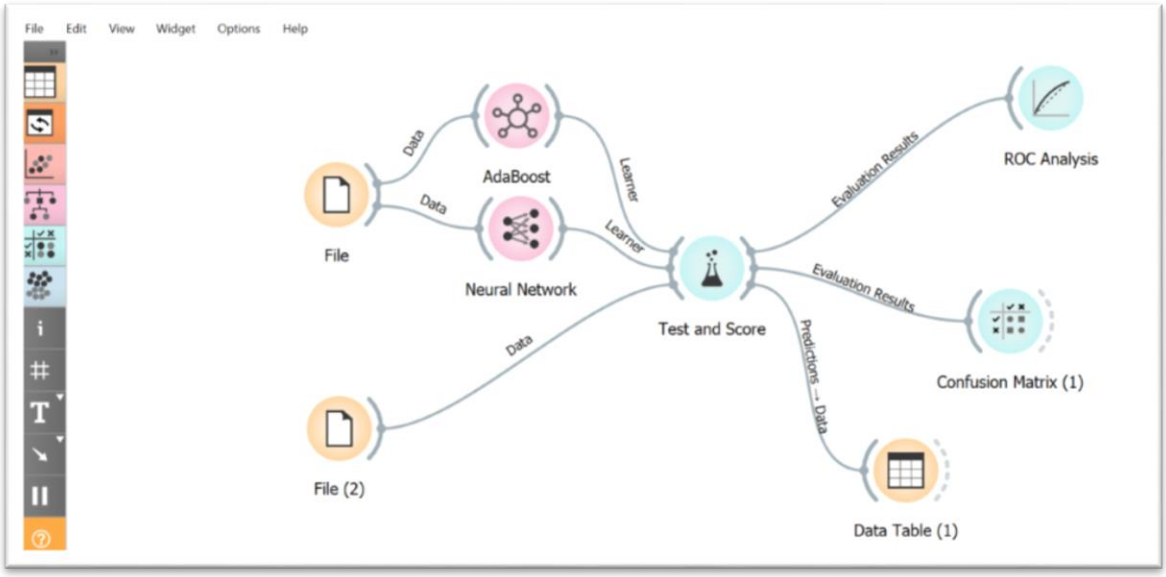


Figure 1. Components of Orange tool

Kaggle data storage platform

Kaggle, backed by Google LLC, is a data storage and sharing platform that provides free online services for data researchers and professionals in software engineering since 2010. Large data sets on Kaggle are stored on cloud systems. Kaggle is a platform for sharing knowledge to find and send datasets to users, research and build models in an electronic data science environment, work with artificial intelligence experts, and address data science challenges (Kaggle, 2022).

Neural network machine learning algorithm

First, in 1943 neurophysiologist Warren McCulloch and mathematician Walter Pitts wrote a paper on how neurons might work. In this article, they modeled a simple neural network using electrical circuits to explain how neurons in the brain work. In 1949, Donald Hebb introduced the concept of Organization of Behavior, pointing out the fact that neural pathways are strengthened each time they are used, and argued that if two nerves fire at the same time, the connection between them becomes stronger (Chung et al., 2009). In the researches of Rosenblat in 1958, Minsky and Papert in 1969, Grossberg in 1976, Hopfield in 1982 and Kohonen in 1984, computers became more advanced and an artificial neural network model was formed by simulating the learning logic of people (Uçan et al., 2006). Later, researchers tested the success of mathematical functions. There are many areas where the neural network model is used. Neural networks are generally examined in 5 basic structures. These are Inputs, weight coefficients, bias (constant), activation function and output value (Balaban and Kartal, 2018). Figure 2 shows the model of the artificial neural network.

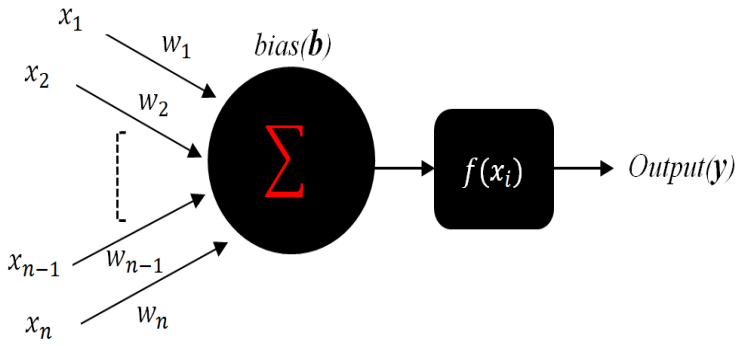


Figure 2. Neural network model

The mathematical expression of the neural network is shown in equation 1. y is the output value, w_i is the weight coefficient, x_i is the input value, and b is the constant coefficient.

$$y = w_i x_i + b \tag{1}$$

AdaBoost machine learning algorithm

By combining many rules, the correct prediction rule creation process is carried out with a machine learning approach. AdaBoost algorithm was first applied in practice by Freund and Schapire in their study in 1996. They proved that this method is a new machine learning algorithm (Freund and Schapire, 1999). It is widely used in many fields with its strong classification ability (Wang et al., 2019).

Adaboost algorithm can be applied to many classifier learning algorithms and strong classification results are obtained. In the AdaBoost algorithm, the "weight" value is calculated by analyzing all the data in the data set (Sun et al., 2006).

With the AdaBoost algorithm, the input value x is divided into two classes as shown in equation 2. The y_ class values are shown as -1 and 1.

$$x_i, x_{i+1}, x_{i+2} \ and \ y_n \in \{-1,1\} \tag{2}$$

Calculation of the weighting coefficient of n pieces of x data is shown in equation 3.

$$w_i = \frac{1}{n} \tag{3}$$

Milk quality dataset

The Milk Quality dataset used in this study was taken from the open source Kaggle data storage area. The dataset data used were obtained from manual observations. Milk samples have 7 attributes: pH, Temperature, Taste Odor, Oil, Turbidity and Color. Generally, the quality of milk is determined by looking at these characteristics. The target is to classify the milk as Low(Poor), Medium(Medium) and High(Good). Taste, Smell, Oil and Turbidity properties take the value 1 or 0. Temperature, pH and Color properties have true color values. Table 1 shows the values of 15 randomly selected milk samples (Kaggle,2022)

Table 1. Milk Quality dataset and classification (Kaggle, 2022)

pH	Temperature	Taste	Odor	Fat	Turbidity	Colour	Grade
6.6	38	1	0	1	0	255	high
6.8	45	1	1	1	1	245	high
6.8	36	0	1	1	0	253	high
6.6	45	0	1	1	1	250	high
6.8	45	1	1	1	1	245	high
6.8	43	1	0	1	0	250	medium
6.8	43	1	0	1	0	250	medium
6.8	43	1	0	1	0	250	medium
6.8	43	1	0	1	0	250	medium
6.8	43	1	0	1	0	250	medium
7.4	65	0	0	0	0	255	low
3	40	1	0	0	0	255	low
9	43	1	1	1	1	248	low
3	40	1	1	1	1	255	low
8.6	55	0	1	1	1	255	low

RESULTS and DISCUSSION

In the study, it was seen that the pH value and temperature value of the milk are an important factor in determining the milk quality. It has been observed that the pH value of high and medium quality milk is between 6-7, and the temperature values are at most 45 degrees. In low quality milk, it was observed that these two conditions did not provide at the same time. The distribution of the results obtained is shown on figure 3.

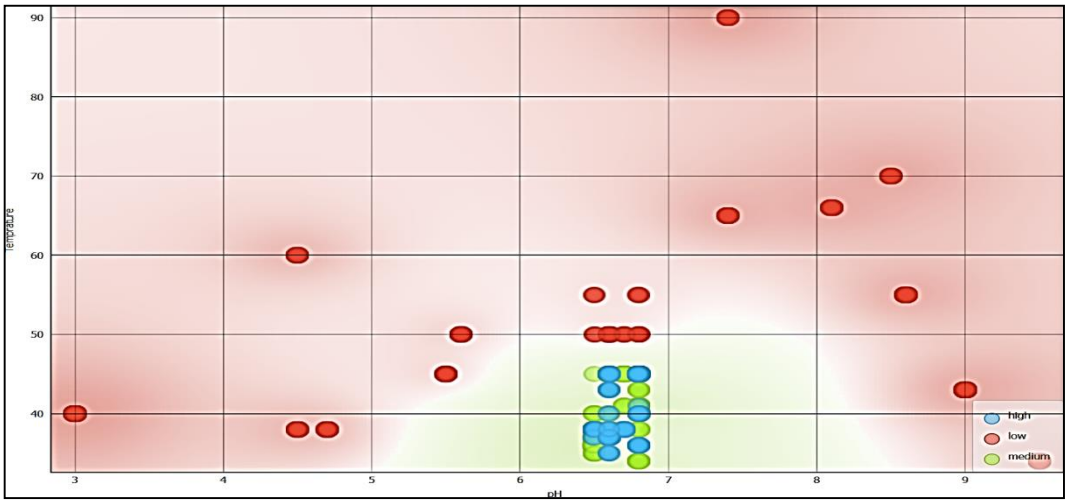
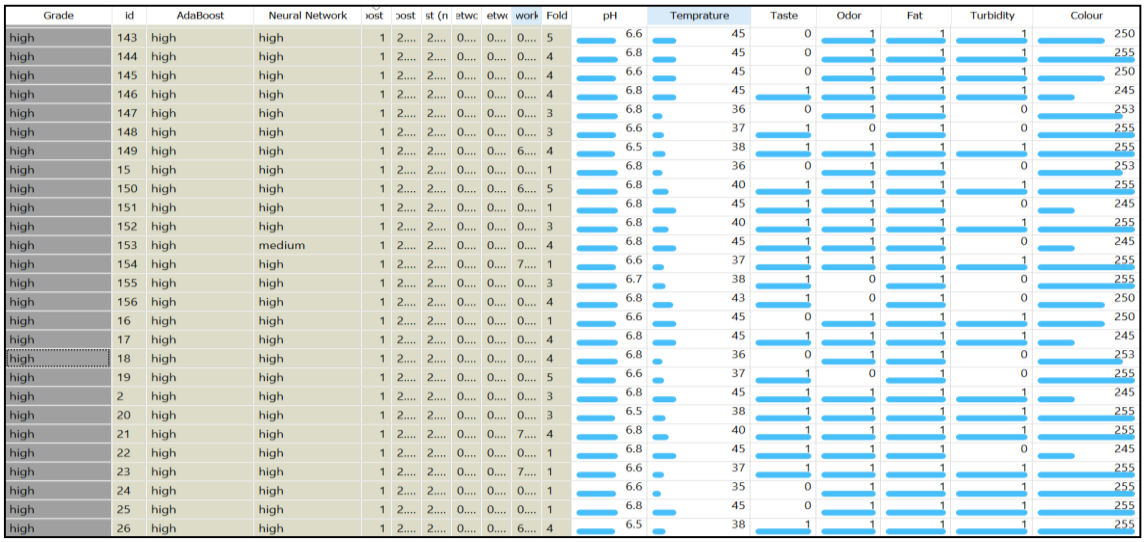


Figure 3. Classification distribution of temperature and pH values

The "high" classification results and attribute data of Milk Quality data with AdaBoost and Neural Network algorithm using Orange Data Mining Tool are shown on Figure 4. The “high” actual values are shown in the Grade field, and the estimated classification prediction results in the AdaBoost and Neural Network field.

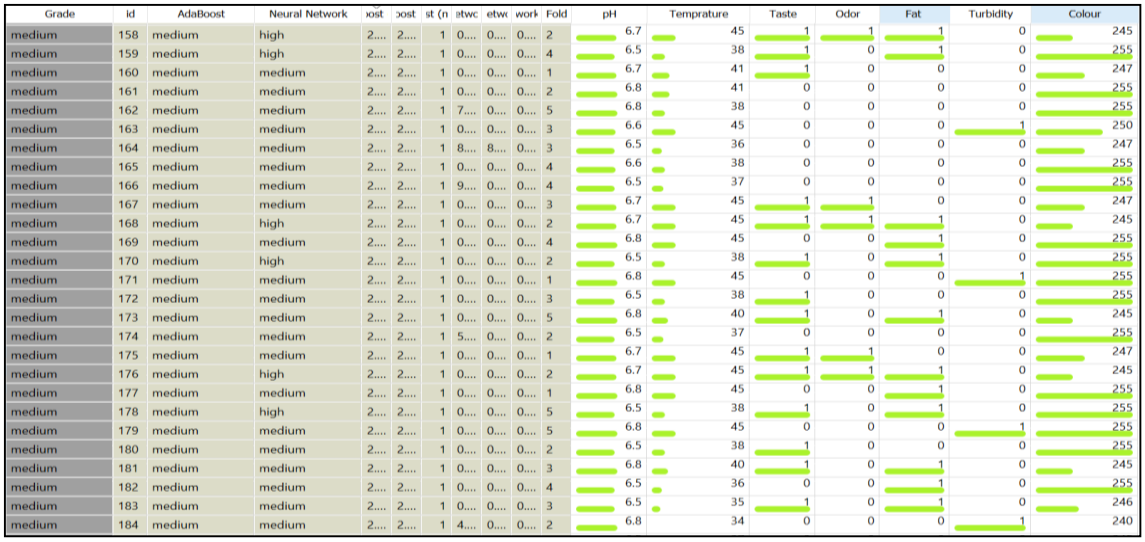
With the Neural Network algorithm, in the example with Id number 153, the quality result that should have been "high" was incorrectly estimated as "medium".



Grade	id	AdaBoost	Neural Network	oost	oost	st (n	atwc	etwc	work	Fold	pH	Temprature	Taste	Odor	Fat	Turbidity	Colour
high	143	high	high	1	2....	2....	0....	0....	0....	5	6.6	45	0	1	1	1	250
high	144	high	high	1	2....	2....	0....	0....	0....	4	6.8	45	0	1	1	1	255
high	145	high	high	1	2....	2....	0....	0....	0....	4	6.6	45	0	1	1	1	250
high	146	high	high	1	2....	2....	0....	0....	0....	4	6.8	45	1	1	1	1	245
high	147	high	high	1	2....	2....	0....	0....	0....	3	6.8	36	0	1	1	0	253
high	148	high	high	1	2....	2....	0....	0....	0....	3	6.6	37	1	0	1	0	255
high	149	high	high	1	2....	2....	0....	0....	6....	4	6.5	38	1	1	1	1	255
high	15	high	high	1	2....	2....	0....	0....	0....	1	6.8	36	0	1	1	0	253
high	150	high	high	1	2....	2....	0....	0....	6....	5	6.8	40	1	1	1	1	255
high	151	high	high	1	2....	2....	0....	0....	0....	1	6.8	45	1	1	1	0	245
high	152	high	high	1	2....	2....	0....	0....	0....	3	6.8	40	1	1	1	1	255
high	153	high	medium	1	2....	2....	0....	0....	0....	4	6.8	45	1	1	1	0	245
high	154	high	high	1	2....	2....	0....	0....	7....	1	6.6	37	1	1	1	1	255
high	155	high	high	1	2....	2....	0....	0....	0....	3	6.7	38	1	0	1	0	255
high	156	high	high	1	2....	2....	0....	0....	0....	4	6.8	43	1	0	1	0	250
high	16	high	high	1	2....	2....	0....	0....	0....	1	6.6	45	0	1	1	1	250
high	17	high	high	1	2....	2....	0....	0....	0....	4	6.8	45	1	1	1	1	245
high	18	high	high	1	2....	2....	0....	0....	0....	4	6.8	36	0	1	1	0	253
high	19	high	high	1	2....	2....	0....	0....	0....	5	6.6	37	1	0	1	0	255
high	2	high	high	1	2....	2....	0....	0....	0....	3	6.8	45	1	1	1	1	245
high	20	high	high	1	2....	2....	0....	0....	0....	3	6.5	38	1	1	1	1	255
high	21	high	high	1	2....	2....	0....	0....	7....	4	6.8	40	1	1	1	1	255
high	22	high	high	1	2....	2....	0....	0....	0....	1	6.8	45	1	1	1	0	245
high	23	high	high	1	2....	2....	0....	0....	7....	1	6.6	37	1	1	1	1	255
high	24	high	high	1	2....	2....	0....	0....	0....	1	6.6	35	0	1	1	1	255
high	25	high	high	1	2....	2....	0....	0....	0....	1	6.8	45	0	1	1	1	255
high	26	high	high	1	2....	2....	0....	0....	6....	4	6.5	38	1	1	1	1	255

Figure 4. "high" classification results and attribute data obtained with AdaBoost and Neural Network algorithms

The results of "medium" classification and attribute data of Milk Quality data with AdaBoost and Neural Network algorithm using Orange Data Mining Tool are shown on figure 5. The "medium" real values are shown in the Grade field, and the predicted classification prediction results in the AdaBoost and Neural Network field. In the samples with Id numbers 158,159,168,176 and 178 with the Neural Network algorithm, the quality result that should have been "medium" was incorrectly estimated as "high".



Grade	id	AdaBoost	Neural Network	oost	oost	st (n	atwc	etwc	work	Fold	pH	Temprature	Taste	Odor	Fat	Turbidity	Colour
medium	158	medium	high	2....	2....	1	0....	0....	0....	2	6.7	45	1	1	1	0	245
medium	159	medium	high	2....	2....	1	0....	0....	0....	4	6.5	38	1	0	1	0	255
medium	160	medium	medium	2....	2....	1	0....	0....	0....	1	6.7	41	1	0	0	0	247
medium	161	medium	medium	2....	2....	1	0....	0....	0....	2	6.8	41	0	0	0	0	255
medium	162	medium	medium	2....	2....	1	7....	0....	0....	5	6.8	38	0	0	0	0	255
medium	163	medium	medium	2....	2....	1	0....	0....	0....	3	6.6	45	0	0	0	1	250
medium	164	medium	medium	2....	2....	1	8....	8....	0....	3	6.5	36	0	0	0	0	247
medium	165	medium	medium	2....	2....	1	0....	0....	0....	4	6.6	38	0	0	0	0	255
medium	166	medium	medium	2....	2....	1	9....	0....	0....	4	6.5	37	0	0	0	0	255
medium	167	medium	medium	2....	2....	1	0....	0....	0....	3	6.7	45	1	1	0	0	247
medium	168	medium	high	2....	2....	1	0....	0....	0....	2	6.7	45	1	1	1	0	245
medium	169	medium	medium	2....	2....	1	0....	0....	0....	4	6.8	45	0	0	1	0	255
medium	170	medium	high	2....	2....	1	0....	0....	0....	2	6.5	38	1	0	1	0	255
medium	171	medium	medium	2....	2....	1	0....	0....	0....	1	6.8	45	0	0	0	1	255
medium	172	medium	medium	2....	2....	1	0....	0....	0....	3	6.5	38	1	0	0	0	255
medium	173	medium	medium	2....	2....	1	0....	0....	0....	5	6.8	40	1	0	1	0	245
medium	174	medium	medium	2....	2....	1	5....	0....	0....	2	6.5	37	0	0	0	0	255
medium	175	medium	medium	2....	2....	1	0....	0....	0....	1	6.7	45	1	1	0	0	247
medium	176	medium	high	2....	2....	1	0....	0....	0....	2	6.7	45	1	1	1	0	245
medium	177	medium	medium	2....	2....	1	0....	0....	0....	1	6.8	45	0	0	1	0	255
medium	178	medium	high	2....	2....	1	0....	0....	0....	5	6.5	38	1	0	1	0	255
medium	179	medium	medium	2....	2....	1	0....	0....	0....	5	6.8	45	0	0	0	1	255
medium	180	medium	medium	2....	2....	1	0....	0....	0....	2	6.5	38	1	0	0	0	255
medium	181	medium	medium	2....	2....	1	0....	0....	0....	3	6.8	40	1	0	1	0	245
medium	182	medium	medium	2....	2....	1	0....	0....	0....	4	6.5	36	0	0	1	0	255
medium	183	medium	medium	2....	2....	1	0....	0....	0....	3	6.5	35	1	0	1	0	246
medium	184	medium	medium	2....	2....	1	4....	0....	0....	2	6.8	34	0	0	0	1	240

Figure 5. "medium" classification results and attribute data obtained with AdaBoost and Neural Network algorithms

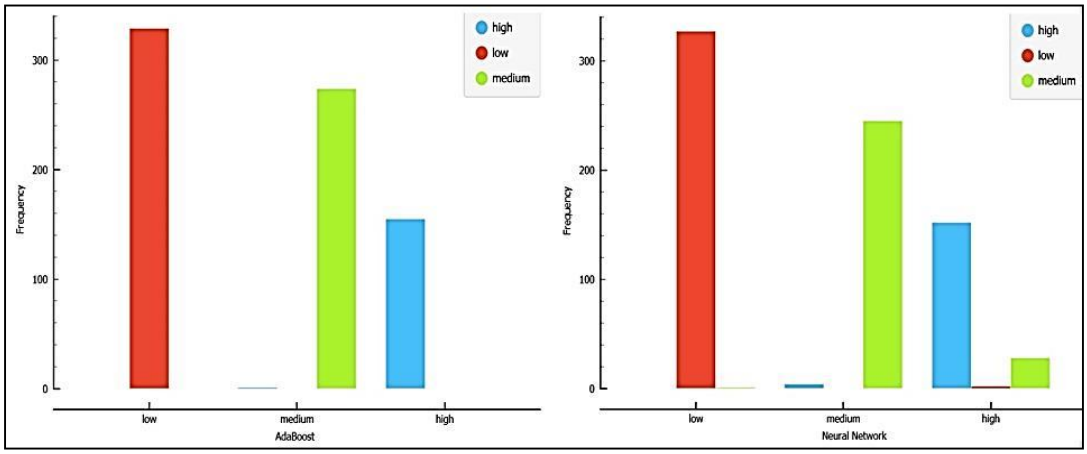
The "low" classification results and attribute data of Milk Quality data with AdaBoost and Neural Network algorithm using Orange Data Mining Tool are shown on Figure 6.

The "low" actual values are shown in the Grade field, and the predicted classification estimation results are shown in the AdaBoost and Neural Network field. In the example with the Id number 747 with the Neural Network algorithm, the quality result that should have been "low" was incorrectly predicted as "high".

Grade	id	AdaBoost	Neural Network	Fold	pH	Temprature	Taste	Odor	Fat	Turbidity	Colour
low	732	low	low	4	4.5	38	0	1	1	1	255
low	733	low	low	1	8.5	70	0	0	0	0	246
low	734	low	low	4	7.4	65	0	0	0	0	255
low	735	low	low	1	3.0	40	1	1	1	1	255
low	736	low	low	4	8.6	55	0	1	1	1	255
low	737	low	low	4	4.7	38	1	0	1	0	255
low	738	low	low	5	3.0	40	1	1	1	1	255
low	739	low	low	2	9.0	43	1	0	1	1	250
low	740	low	low	1	3.0	40	1	1	1	1	255
low	741	low	low	4	9.0	43	1	0	1	1	250
low	742	low	low	4	4.7	38	1	0	1	0	255
low	743	low	low	4	3.0	40	1	1	1	1	255
low	744	low	low	2	9.0	43	1	0	1	1	250
low	745	low	low	1	4.5	38	0	1	1	1	255
low	746	low	low	5	8.5	70	0	0	0	0	246
low	747	low	high	4	6.5	37	0	1	1	1	245
low	748	low	low	5	7.4	65	0	0	0	0	255
low	749	low	low	3	3.0	40	1	0	0	0	255
low	750	low	low	2	9.0	43	1	1	1	1	248
low	751	low	low	3	6.6	50	0	0	0	1	250
low	752	low	low	3	6.6	50	0	0	0	0	255
low	753	low	low	2	9.0	43	1	1	1	1	248
low	754	low	low	4	6.6	50	0	0	0	1	250
low	755	low	low	5	9.5	34	1	1	0	1	255
low	756	low	low	2	5.5	45	1	0	1	1	250
low	757	low	low	3	8.1	66	1	0	1	1	255
low	758	low	low	3	3.0	40	1	1	1	1	255

Figure 6. “low” classification results and attribute data obtained with AdaBoost Neural Network algorithm

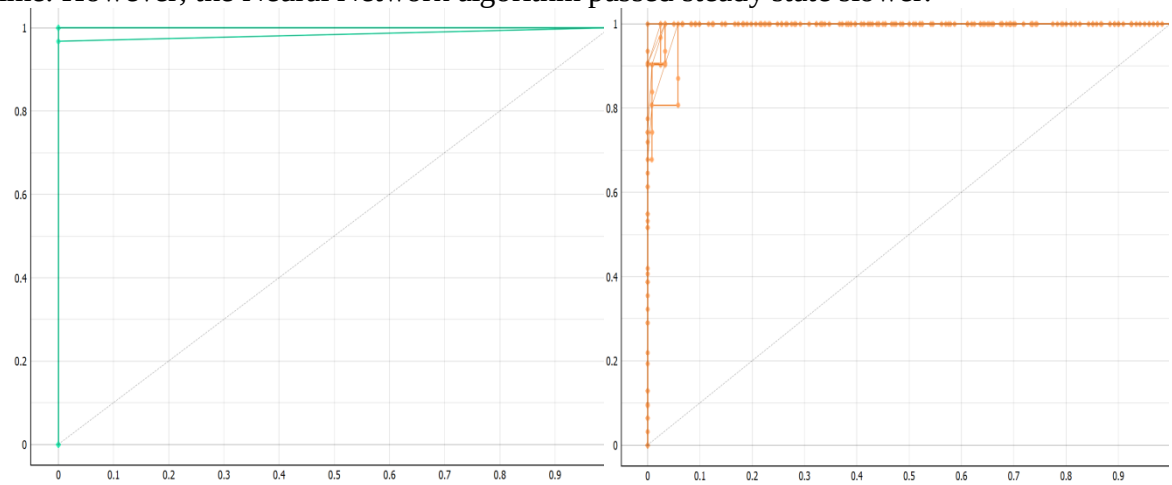
The frequencies of classification distributions of AdaBoost and Neural Network algorithms are shown on figure 7. Blue color indicates "high", Green color indicates "medium" and Red color indicates "low" classification. When the results are compared, it is seen that there is only a very small amount of error in the "medium" classification in the AdaBoost algorithm. However, it is seen that there are incorrect results in all classification predictions with the Neural Network algorithm.



(a) (b)

Figure 7. Classification distributions and frequencies of machine learning algorithms (a) AdaBoost algorithm classification prediction distribution (b) Neural Network algorithm classification prediction distribution

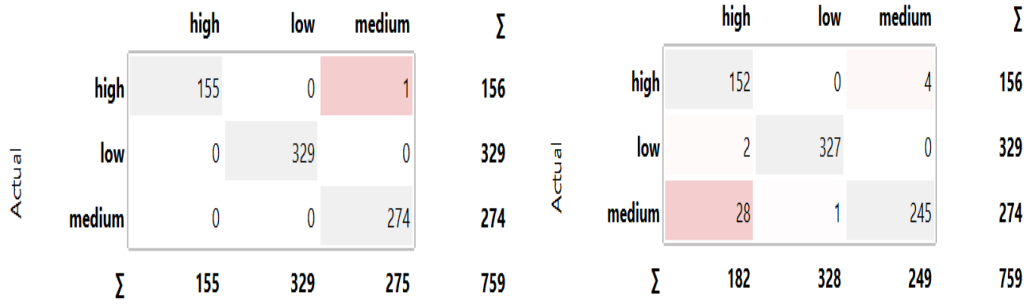
The stability graphs of the algorithms according to the classification estimation results are shown in Figure 8. It is seen that the Adaboost algorithm becomes stable in a very short time. However, the Neural Network algorithm passed steady state slower.



(a) (b)

Figure 8. Classification ROC curves of machine learning algorithms (a) ROC curve of AdaBoost Algorithm (b) ROC curve of Neural Network Algorithm

The complexity matrix value graphs of the algorithms according to the classification estimation results are shown on Figure 9. With the Adaboost algorithm, only one data belonging to the "high" class was incorrectly predicted as the "medium" class. However, with the Neural Network algorithm, 4 data belonging to the “high” class were incorrectly predicted as “medium”, 28 data belonging to the “medium” class were incorrectly predicted as “high” and 2 data belonging to the “low” class were also “high” was incorrectly predicted.



(a) (b)

Figure 9. Machine learning algorithms, classification Complexity Matrix values (a) Complexity matrix of AdaBoost Algorithm (b) Complexity matrix of Neural Network Algorithm

The metric values of the results obtained with both algorithms are shown on table 2. Area Under Curve (AUC), Classification accuracy (CA), F1 score, Precision and Recall parameters were used as metric values. With the AdaBoost algorithm, 99.9% accuracy estimation was achieved in all metric values. The highest success rate with the Neural Network algorithm was obtained with the AUC metric value, but the CA parameter was used as the success metric in this study. As a CA parameter, 99.9% success rate was obtained with the AdaBoost algorithm and 95.4% with the Neural Network algorithm.

Table 2. Metric success rates of algorithms

Model Name	AUC	CA	F1	Precision	Recall
AdaBoost	0.999	0.999	0.999	0.999	0.999
Neural Network	0.997	0.954	0.955	0.959	0.954

CONCLUSION

On the basis of machine learning algorithms, artificial intelligence applications are used efficiently in many sectors. Systems developed by using machine learning algorithms facilitate human life and obtain reliable results. The use of these systems in the food industry will be beneficial. The use of machine learning systems will be beneficial, especially for the quality determination of products with sufficient data attributes.

In this study, it has been shown that milk quality can be determined by using machine learning algorithms. AdaBoost and Neural Network algorithms were used as machine learning algorithms. Milk Quality, which was downloaded from Kaggle storage, was used as the data set. There are 1059 milk data samples from this dataset. In the data set, 7 features of each sample were used. As features, pH, Temperature, Taste Odor, Oil, Turbidity and Color data were used. Orange Data Mining Tool was used as the application software interface.

According to the results obtained, in the system trained using 100 samples belonging to each class, 99.9% success rate with AdaBoost algorithm, 95.4% with Neural Network algorithm, classification accuracy were determined. The results are presented visually and compared by giving the ROC curve, complexity matrix and metric values. This study has shown that machine learning algorithms will provide high accuracy success in determining the quality of dairy products.

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Changes in Total Phenolic Content and Antioxidant Activity of Grapefruit and Mandarin Peels Extracted with Different Solvents

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Abstract

In this research, different solvents were used for the extraction of grapefruit and mandarin peels in order to determine the effects of solvents on the total phenolic content (TPC) and antioxidant activity of peels. According to the results, the higher TPC and antioxidant activity values were determined in the ethanol extract of grapefruit peels as 666.55 mg GAE/g and 428.60 µmol trolox/g, respectively. Acetone extract of peels showed the lowest values both in the mandarin and grapefruit peels. Total phenolic content of mandarin and grapefruit peels were reported as 32.05 and 50.26 mg GAE/g in the acetone extraction. To conclude the results, TPC and antioxidant activity of mandarin and grapefruit peels showed differences with different solvent extraction.

Keywords: Ethanol, methanol, acetone, peel, phenolic compounds, antioxidant activity

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INTRODUCTION

Citrus belongs to the Rutaceae family which is a shrub cultivated in tropical, sub-tropical and temperate regions of the world. It consists of fruits such as oranges, tangerines, lemons, grapefruits and other citrus varieties. It is found all round the year although oranges and grapefruit, reach to mature stage between mid-December and April in the Northern Hemisphere (Abobatta, 2019). Global citrus production is estimated at 80 million tons per year (Spiegel-Roy et al., 1996; Bocco et al., 1998). Citrus fruit has components that are beneficial to the health and it is considered to be one of the most important fruits in the world. Some of these components include vitamins C, carotenoids, flavonoids, pectin, calcium and potassium. It also contains soluble and insoluble fiber and can also aid in the removal of toxins from the body (Pragasam et al., 2013). The yield of juice obtained from citrus (mainly orange and grapefruit) is less half of the fruit weight and large quantities of citrus by-product (peels) which constitutes waste are gathered every year (Manthey et al., 2001). On the other hand, about 25% to 30% of non-edible fruit yield is peels and seeds (Ajila, 2010). In most cases these non-edible fruit yield by-products contain high contents of antioxidant and antimicrobial compounds that can be successfully utilized as a source of phytochemicals, antioxidant, antimicrobial, antifungal, antibacterial and antivirus agents (Ayala-Zavala et al., 2004). Agricultural and industrial by-products have been used recently and many studies have been conducted on the usage of these by-products in the maintenance of food quality (Ucak, 2019; Ucak et al., 2019; Ucak et al., 2018; Ucak, 2020).

The major advantages of using citrus peels industrial left-over or waste are that it is readily obtainable and provide inexpensive source of biomass which can be used in the health, nutrition and cosmetic industries (Chavan et al., 2018). They are rich in natural flavonoids such as flavanone glycosides, polymethoxylated flavones and flavanones (Cheigh et al., 2012). A considerable amount of valuable by-products are produced during the processing of citrus fruits (Ucak et al., 2021). In addition, citrus peels are abundantly available, cheap and economical wastes of plant origin which can be used to treat lifestyle diseases. Hence, citrus peels can be used in food and food additives as a useful ingredient for potential health properties or as a substitute for chemical stabilizers (Singh et al., 2020).

Citrus peel is including two parts, flavedo and albedo (flavedo) is the external part which is mainly rich in carotenoids and essential oils and the internal spongy portion (albedo) which is rich in phenol and pectin (Espiard, 2002; Ramful et al., 2010; Bejar et al., 2011). Hence, with these outstanding features, a number of studies recommended that citrus left-over or waste could be used as natural additive or natural source of antioxidants to take advantage of these wastes (Bocco et al., 1998; Llorach et al., 2003; Manthey et al., 2001; Wolfe, 2003; Yerlikaya et al., 2015; Yerlikaya et al., 2017; Irkin et al., 2015). In future, for estimation of antioxidant capacity of the citrus fruit, wasted part is required, which is used to explore the potential of their usage in food industries. Therefore, the purpose of this study is to evaluate the capacity of antioxidant activity and phenolic content in citrus peels with different solvent extraction.

MATERIALS AND METHODS

Extraction of peels

Mandarin and grapefruit were obtained from a local market in Niğde province. Peels were provided by squeezing of the fruits. Then the peels were carefully washed, oven-dried for 24-26 hours at 50ºC until constant weight was obtained and grounded into powder. Extraction process was conducted with different solvents such as ethanol, methanol and acetone. 10 g of mandarin and grapefruit peels powder dissolved in 100 ml of 70% acetone, ethanol and methanol. The mixture was stirred by an ultrasonic water bath for 30 min and then filtered. Ethanol was evaporated at 50°C, methanol was evaporated at 55°C, and acetone was evaporated at 45°C with a rotary evaporator under vacuum.

Analyses

Total phenolic content

Folin-Ciocalteu colorimetric method was used for the determination of total phenolic contents (TPC) at 765nm and expressed as gallic acid equivalent (GAE) according to the method described by (Re, R., et al. 1999). The samples were added to Folin-Ciocalteu reagent and Na_2CO_3 solution and placed in a dark place at 24°C for 2h. Results were expressed as mg gallic acid equivalents/ml sample (GAE/g sample). The standard curve was prepared by 160, 140, 120, 100, and 80 mg/ml solutions of gallic acid in ethanol, methanol, and acetone: water with the ratio 70:30 (v/v).

Antioxidant activity

A 7 mM ABTS solution covering 2.45 mM potassium persulfate was prepared and the radical solution (ABTS + •) was made by putting for 16 hours at room temperature in the dark place. 10 µl of sample was added on 1 ml ABTS + and a decrease in absorbance was observed for 6 minutes. (Re et al., 1999) The standard curve was prepared by 40, 60, 80, 100,120, 160, 170 and 180 mg/ml solutions of 1 mM trolox in ethanol, methanol, and acetone: water by the ratio 70:30 (v/v).

Statistical analysis

All samples were carried out three times and analyzed by using the SPSS software (Statistical Analysis System, Cary, NC, USA). Variance analysis (ANOVA) was used to evaluate the data and significance level of Duncan's test was done to compare the differences between means of parameters.

RESULTS AND DISCUSSION

Antioxidant activity

Total antioxidant activity of mandarin and grapefruit peels extracted with different solvents was given in Table 1.

Table 1. Changes in total antioxidant activity (µmol trolox/g) of mandarin and grapefruits peels extracted in different solutions

	Ethanol	**Methanol**	**Acetone**
Mandarin peel	425.51 ± 32.02^{Aa}	256.72 ± 2.87^{Bb}	124.45 ± 2.91^{Cb}
Grapefruit peel	428.60 ± 50.94^{Aa}	349.08 ± 21.53^{ABb}	303.72 ± 17.49^{Ba}

Different capital letters indicate a significant difference among solvents, and different lower-cases letters indicate a significant difference between groups ($P < 0.05$).

The antioxidant activity values of mandarin peels extracted in ethanol, methanol, and acetone solutions were found as 425.51, 256.72 and 124.45 µmol trolox/g, respectively, while this value was higher in grapefruit peels extracts as 428.60, 349.08 and 303.72 µmol trolox/g, respectively. The highest antioxidant activity value was found in the ethanol group, while the lowest value was observed in the acetone group both in the mandarin and grapefruit peels. Ferreira et al. (2018) reported the values of hydro-ethanolic extract from mandarin orange as 322 µmol Trolox/100 g. However, the result obtained in this study for mandarin peel was higher as 425.51 µmol trolox/g. According to (Ghasemi et al., 2009), antioxidant activity of grapefruit peel methanolic extract was 2.1 mg/mL IC50. (Guimarães et al., 2010) reported that the antioxidant activity value of grapefruit peel methanolic extract was 5.15 mg/ml IC50. The reason for these differences might be due to diverse types of extraction, method and solvent used, as well as the different origin of the samples. It was reported that the antioxidant activity of albedo fragments of bitter orange was 0.537±µM trolox (Yerlikaya et al., 2017).

In another study, it was determined that the total antioxidant activity of grapefruit albedo and flavedo fragments were 0.103 and 0.183 μM TEAC, respectively.

Total phenolic content

The results of total phenolic content (TPC) of mandarin and grapefruit peels extracted with different solvents are presented in Table 2.

Table 2. Changes in total phenolic content (mg GAE/g) of mandarin and grapefruit peels extracted in different solvents

	Ethanol	**Methanol**	**Acetone**
Mandarin peel	387.70 ± 9.14^{Ab}	84.823 ± 0.5832^{Bb}	32.05 ± 0.09^{Cb}
Grapefruit peel	666.55 ± 1.22^{Aa}	160.29 ± 11.66^{Ba}	50.26 ± 1.79^{Ca}

Different capital letters indicate a significant difference among solvents, and different lower-cases letters indicate a significant difference between groups ($P < 0.05$).

Total phenolic content (TPC) of mandarin and grapefruit peels extracted with ethanol were found as 387.70 and 666.55 mg GAE/g, respectively. The lowest TPC values were observed in the acetone extracts as 32.05 and 50.26 mg GAE/g in mandarin and grapefruit peels, respectively. Grapefruit peels extracts showed higher TPC values than the mandarin peels extracts in all solvents. The highest TPC values were found in the ethanolic extraction of both peels. In a study, (Fejzić., 2014) used percolation with ethanol extract and the highest phenolic content was determined in the mandarin peel (0.334 mg GAE/g), while the lowest content was found in the red grapefruit peel (0.283 mg GAE/g). (Petchlert et al.,2013) reported the TPC value of mandarin as 5.71 mg GAE/ml. The phenolic content determined in albedo fragments of bitter orange was 8.31 g GAE/100g (Yerlikaya et al., 2017). As a reporte the TPC of bitter orange (*C. aurantium* L.) as 0.51 mg GAE/100 g dietary fiber (Garau et al., 2007). Extraction parameters like temperature, time, raw material and solvents have effects on the differences in the TPC and antioxidants activity.

CONCLUSION

This study based on the effects of different solvents on the total phenolic content and antioxidant activity of some citrus peels. According to the results, ethanolic extract of both mandarin and grapefruit peels showed highest total phenolic content and antioxidant activity values, while the lowest values were observed in acetone extraction. Comparing with the mandarin, grapefruit peels showed higher total phenolic content and antioxidant activity in all solvents extraction. It has been concluded that the highest antioxidant and phenolic content of Grapefruit and Mandarin Orange peels, recently started an important area of research with ethanol and acetone extraction use in the health, food, and cosmetics sectors.

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Effect of Sex on The Nutritional Content of Some Fresh Water Fish Species (Carp-*Cyprinus carpio*, Pike-*Sander lucioeperca* and Pike perch-*Esox lucius*)

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Abstract

In this study, the muscle nutrient content of freshwater fish sold by fishermen in Aksaray province was determined. Carp (*Cyprinus carpio*), pikeperch (*Sander lucioeperca*), and pike (*Esox lucius*) fish used in the study were first sexed and then filleted. Crude protein (CP), Crude fat (CF), Crude ash (CA), and Moisture (M) amounts were determined from muscle tissue taken from the dorsal region of male and female fish. When the nutrient content of carp meat was analyzed, 18.25%, 1.46%, 1.26%, and 78.91% were found, respectively. The nutrient content of the muscle tissue of pikeperch was 18.08% (CP), 1.58% (CF), 1.09% (CA), and 79.14% (M), while the nutrient content of pike was 17.17% (CP), 1.59% (CF), 1.35% (CA) and 79.78% (M). In our study, in the evaluation made according to gender differences, the highest crude protein was measured in male pikeperch (18.49%), and the lowest crude protein ratio was measured in male pike (16.81%). When our fish were sorted according to their fat ratios, the highest crude fat was measured in male pikeperch (1.97%), and the lowest crude fat ratio was measured in female pikeperch (1.18%).
As a result, it was found that the nutrient content of the fish species analyzed in this study differed according to both species and gender.

Keywords: Proximate Composition, Carp, Pikeperch, Pike, Gender

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INTRODUCTION

In recent years, with the effect of epidemic diseases, consumers have started to give more importance to their nutrition, and thus the demand for seafood consumption is increasing. Furthermore, as the positive impact of seafood, especially fish oils, on human health are better known, people have begun to ask about the nutritional content of the fish they consume. This awareness of consumers has caused the fish species they prefer to change according to the seasons, as well as a change in fish consumption patterns. Knowing the nutritional content of fish and especially the crude fat ratios of fish is very important in terms of determining how to cook the fish, with which processing method it will be processed, with which spices or oils it will be cooked, and if it will not be consumed fresh and will be stored, the storage period (Öksüz et al., 2019; Öz and Uçak, 2021).

Many studies are conducted to determine the muscle nutrient content of fish (Öz and Dikel, 2022; Taşbozan et al., 2016; Öz, 2016; Öz et al., 2021; Nazari et al., 2017; Öz and Dikel 2015; Zare et al., 2021; Oz et al., 2018).

It is not always easy to reach fresh fish, especially in inland areas far from the sea, when fishing from the sea is prohibited. Consumers meet their aquaculture needs with fish from the cultural environment and frozen fishery products or fish caught from inland waters. Some regions' most popular and preferred fish are carp, pikeperch, and pike.

Carp (*Cyprinus carpio*) is an important freshwater fish species widely distributed due to its low water quality parameters and nutritional requirements. Carp is one of the most easily accessible fish species in many regions, as it is a fish species caught and farmed in inland waters (Öz & Üstüner, 2021). Pikeperch (*Sander lucioperca*) is a carnivorous freshwater fish in the Percidae family. It is also known by names such as freshwater perch, lake perch, white fish, white perch, German perch, and toothed fish, and its body length can reach 1.25 meters, and its weight can reach 19 kilograms (Başyiğit, 2012). Pikeperch is a fish with high economic importance and is consumed with favor. It is considered an economically important species due to its low bones, rich nutritional content, and deliciousness (Çaklı, 2007). The pike (*Esox lucius* L, 1758) is an important Freshwater fish species that live in clean and densely vegetated lakes, stagnant ponds, and sub-basins of large rivers (Page & Burr, 2011). Pike, which has a carnivorous diet, is one of the economic species found in large quantities in Turkey's inland waters. The role of this species in the food chain, which is the food of humans and heron birds, is very important (Çelik, Kaya, & Yılmaz, 2012).

It is known that many factors affect the change in the muscle nutrient content of fish species. This study aimed to determine the nutrient content of carp, pikeperch, and pike, mostly hunted for human consumption in inland waters, by considering gender differences.

MATERIAL and METHOD

Preparation of Fish for Analysis

Our fish were supplied fresh from a fisherman operating in Aksaray. They were brought to the Aksaray University Veterinary Faculty Fisheries and Diseases Department laboratory in the cold chain and prepared for analysis. In our research, three fish hunted in the Central Anatolian Region and consumed lovingly in this region were used. The sexes of pikeperch (*Sander lucioeperca*), carp (*Cyprinus carpio*), and pike (*Esox lucius*) used in the study were determined first, and then their fillets were removed and analyzed.

Nutritional Content Analysis

Crude protein analyzes were performed according to the Kjeldahl method using 1 g of homogenized sample (AOAC, 1998). Lipid analysis was performed according to the method applied by Bligh and Dyer (1959). Porcelain crucibles used in crude ash analysis were dried in an oven at 103 ºC for 2 hours, cooled in a desiccator, and tared on a 0.1 mg sensitive precision balance. 3.3-5 g of the homogenized sample was weighed into the crucibles, and these samples were burned at +550 ºC for 4 hours until their color turned light gray. Then, after cooling to room temperature in a desiccator, they were weighed on a precision balance (AOAC, 1990). Moisture analysis was based on the method applied by AOAC (1990).

Statistical Analysis

The data obtained at the study's end were evaluated using the SPSS 15.0 package program. Duncan's multiple comparison test (P<0.05 significance level) One-way ANOVA was applied to compare the data obtained as a result of the analysis of carp, pikeperch, and pike fish obtained fresh from fishermen.

RESULTS and DISCUSSION

In our research, the nutritional contents of male and female individuals of three freshwater fish species, which are the most sold by fishermen in Aksaray province and obtained through hunting, were determined. The results are given in Table 1.

Table 1. The nutritional content of Pike, Carp, and Pikeperch meat

Fish species and gender	Crude protein	Lipid	Crude ash	Moisture
Pike (♂)	16,81±0,49^{C}	1,69±0,01^{B}	1,40±0,01^{A}	79,98±0,46^{A}
Pike (♀)	17,54±0,06^{B}	1,50±0,05^{C}	1,31±0,01^{B}	79,58±0,06^{A}
Pikeperch (♂)	18,50±0,22^{A}	1,98±0,08^{A}	1,02±0,00^{E}	78,44±0,28^{B}
Pikeperch (♀)	17,68±0,13^{B}	1,19±0,02^{D}	1,17±0,02^{D}	79,84±0,12^{A}
Carp (♂)	18,43±0,20^{A}	1,72±0,03^{B}	1,27±0,01^{C}	78,44±0,27^{B}
Carp (♀)	18,08±0,23^{AB}	1,21±0,02^{D}	1,25±0,01^{C}	79,39±0,22^{A}

Crude protein, crude fat, crude ash, and moisture content of pike meat were found to be 16.81-17.54%, 1.69-1.50%, 1.40-1.31%, and 79.98-79.58% in males and females, respectively. Crude protein, crude fat, crude ash, and moisture content of pikeperch meat were calculated as 18.50-17.68%, 1.98-1.19%, 1.02-1.17%, and 78.44-79.84% for males and females, respectively. In this study, crude protein, crude fat, crude ash, and moisture content of carp meat were 18.43-18.08%, 1.72-1.21%, 1.27-1.25%, and 78.44-79.39% for males and females, respectively (Figure 1 and Figure 2).

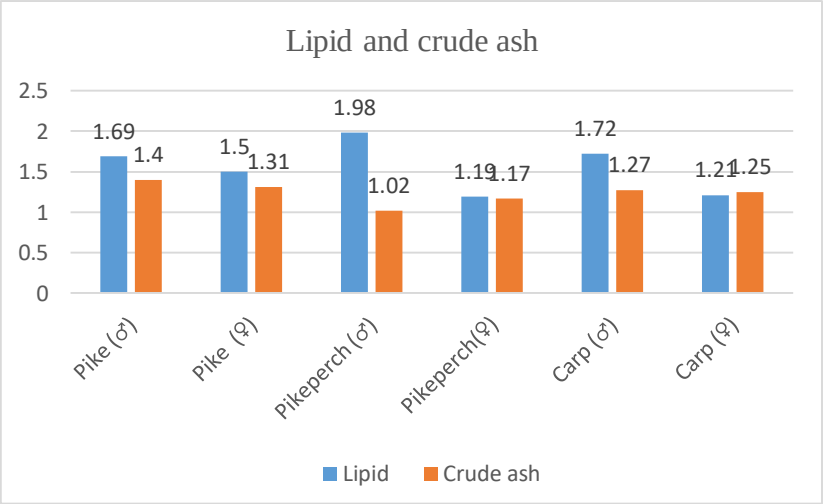

Figure 1. Crude fat and crude ash ratios of Pike, Carp, and Pikeperch meat

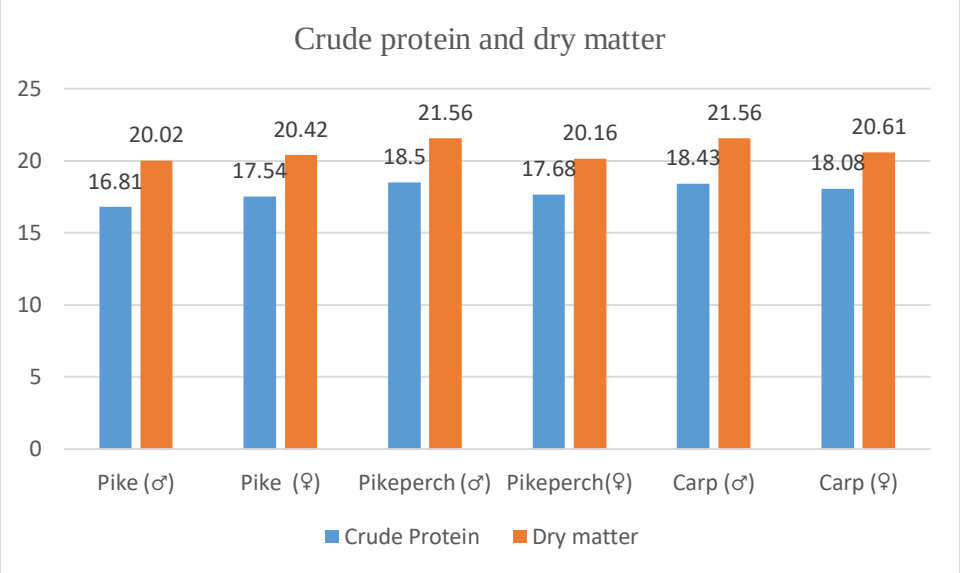

Figure 2. Crude protein and dry matter content of Pike, Carp, and Pikeperch meat

In the species-based evaluation without considering the gender separation, the highest crude protein was measured in carp (18.25%), and the lowest crude protein ratio was measured in pike (17.17%). When our fish species were ranked according to their fat ratios, the highest crude fat was found in pike (1.60%), and the lowest crude oil ratio was in carp (1.46%). The highest protein rate was calculated in the males of the pikeperch fish (18.50%), and the lowest protein ratio was calculated in the males of the pike (16.81%). When the moisture content of the meat taken from three freshwater fish species was examined, the highest moisture content was calculated in male pikes and the lowest moisture content in the meat of pikeperch. In our study, in the analyzes made from the samples taken from our fish meat, the highest fat rate was found in male pike perch, while the lowest fat rate was found in female carp meat. In our study, the highest fat rate was found in the meat of male pike, while the lowest fat rate was found in the meat of female carp.

Fish species are analyzed in four different groups according to their fat content. Fish with less than 2% fat is classified as lean fish, fish with 2-4% fat is classified as low-fat fish, fish with 4-8% fat are classified as medium-fat fish, and fish with more than 8% fat are classified as high-fat fish (Ackman, 1990). According to this grouping, the carp, pike, and pike perch we used in our research are lean fish. In a previous study conducted in Turkish waters, the oil rate of carp was found to be 3.33%, and it was evaluated as a low-fat fish. In the same study, the fat ratio of pike perch (1.73%) was similar to our research results and was shown in the low-fat fish class of pike perch (Öksüz et al., 2019).

Orban et al. (2007) reported crude protein as 17.89%, crude fat as 0.90, crude ash as 1.21%, and moisture as 80.28% in a study they conducted to determine the nutritional content of pike perch (*Perca fluviatilis*) caught from three different lakes. A study conducted in Beyşehir lake investigated the nutritional composition of Carp and Pikeperch fish. In the study, the crude protein rate of carp meat was reported as 17.40%, the crude ash rate was 1.12%, the moisture rate was 78.87%, and the crude fat rate was 3.33%. In the same study, it was reported that the crude protein rate of pikeperch meat was 18.97%, the crude ash rate was 1.04%, the moisture rate was 79.43%, and the crude oil rate was 1.73% (Öksüz et al., 2019).

In a study conducted by Ljubojevic et al., (2013) in December, the moisture content of carp was found to be 73.6%, crude protein 15.64%, crude fat 10.07%, and crude ash 1.14%, while these values were reported as 77.85%, 19.27%, 1.8%, and 1.04%, respectively in pikeperch (Ljubojevic et al., 2013). In the carp caught from the Danube river, the protein rate was 16.69%, and the fat rate was 7.3% (Ljubojević et al., 2017). In a study examining whether the nutritional content of pike varies according to gender and living environment, it was reported that the moisture rate was 74.42-80.30%, the crude protein rate was 17.44-22.33%, the crude ash rate was 1.27%-1.40%, and the crude fat rate was between 0.69-1.89% (Modzelewska- Kapitula et al., 2017).

CONCLUSION

The results obtained in this study are very consistent with the literature. The values obtained are lower than in some studies, higher than in some studies, and very close to the results of some studies. When the reasons for these differences are examined, one of the most important factors is the season and the environment in which the fish live. In general, it was determined that the fish were more oily in the samples made in the autumn and before the winter season, and the oil rate of the fish was low in the analyses made at the end of the winter, that is, in the first spring, as in our study. As a result, the nutritional contents of males and females of three fish species, mostly caught and consumed with pleasure in fresh waters, were extracted and evaluated. It was concluded that the nutrient content of fish varies between species as well as by gender.

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Evaluation of Food Safety and Nutritional Quality of Indigenous Beverages Vended in Informal Market of Nasarawa State, North Central, Nigeria

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Abstract

Food security encompasses increased production, supply, and consumption of wholesome food, but poor food quality and safety jeopardizes the entire production, distribution, and ultimately consumption. Expanding the food chain to accommodate indigenous species is an important way to enhance overall human health and well-being, and improve food security as they form an important part of people's food intake all over local communities in the global south. However, due to poor food safety knowledge and practices, poverty, and illiteracy among consumers and vendors of indigenous foods, various unsafe and hazardous food safety practices abound that compromise the nutritional quality of the beverages and pose threat to public health, so their safety and quality require routine scrutiny. This study was carried out to evaluate the Food Safety and Nutritional Quality of Indigenous Beverages Vended in Informal Market of Nasarawa State, North Central, Nigeria. Fifty-five (55) samples of *Kunu Zaki, Zobo, Fura de Nono, Kunu Aya, Kunu Gyada* were obtained from street hawkers randomly from various open markets within the metropolis. The beverages were analyzed for proximate, physiochemical, micronutrient (Ca, Fe, Zn, Ca, and Mg), and microbial isolates using standard methods. The proximate quality of the beverage's samples was in the range of carbohydrate (3.55 to 23.28%), proteins (2.10 to 7.31%), fat (0.90 to 7.77%), crude fibre (0.15 to 2.15%), ash (0.83 to 1.99%), and moisture (66.13 to 85.38%). The physiochemical quality of the beverages was pH (4.22% to 5.53%), Titrable Acidity (0.025 to 5.85), Total soluble solid (0.485 to 10.36%), Total Solid (8.85 to 20.58%). The micronutrient result shows Ca (3.37 to 46.57mg/ml), Fe (0.47 to 45.67 mg/ml), Zn (0.35 to 34.87), Mg (1.84 to 23.34mg/ml). The microbial isolates include bacterial *Bacillus, Enterobacter, Lactobacillus, Micrococus, Salmonella, Staphylococcus, Streptococcus, Escherichia, Klebsiella, Lactobacillus and Pseudomonas.* The microbial safeties of most of the beverages were not more than the recommended standard.

Keywords: Food safety, Nutritional Quality, Indigenous Beverages, Nigeria, Informal Market, Food borne disease, Artisanal Beverages

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INTRODUCTION

Numerous conversations around food security focus on providing food for the projected nine billion people by 2050. Also, policies of several global food and health organisations focus on increased food production (Eke and Elechi, 2021). However, the issue of food security goes beyond simply increasing food production, supply, and consumption of food. The production and distribution efforts and capacities are at risk of being invalided by poor food safety and quality (Eke and Elechi, 2021). Unsafe foods reduce the quantity and quality of agricultural production, thereby reducing food availability and reducing food access for households whose incomes depend on their sale. Moreover, when contaminated food is eaten, there is an increased risk of malnutrition and illness. The Food and Agriculture Organization of the United Nations defines food security as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO 2002). Therefore, for people to be food secure, the safety and nutritional qualities of the food system must be constantly guaranteed, irrespective of how primitive, cultural, indigenous/traditional, modern, or technically advanced the food systems of the people may be. In nutritionally malnourished societies, food security and food choices are framed by the local context of food availability, accessibility, affordability, and attractiveness, and generally regarded as safe plant and animal-based food products. According to WHO (2019) as cited in Gizaw, (2019) "Unsafe food containing harmful bacteria, viruses, parasites, or chemical substances cause more than 200 diseases—ranging from diarrhoea to cancers. An estimated 600 million individuals worldwide took ill after eating contaminated food and 420,000 die every year, resulting in the loss of 33 million disability-adjusted life years (DALYs). Children under 5 years of age carry 40% of the food-borne disease burden, with 125,000 deaths every year. Diarrheal diseases are the most common illnesses resulting from the consumption of contaminated food, causing 550 million people to fall ill and 230,000 deaths every year". Despite the central role that Indigenous foods potentially play in meeting the food security of Nigerians, their safety and nutritional qualities are a source of concern because of the potential for foodborne illness outbreaks as a result of both risky food preparation and eating behaviour (Eke and Elechi, 2021).

Indigenous beverages are local drinks made from animal milk, cereal-legumes, fruits and some vital herbs/spices using traditional knowhow and methods passed down by ancestral practices. Many of which could be classified as unregulated beverages and generally referred to as artisanal, illicit, or illegal drinks in more educated communities (Nwaiwu *et al*., 2020). However, being unregulated is not sufficient grounds to label indigenous beverages as illicit drinks. The origins and production of indigenous beverages is based on the cultural beliefs and practices that have served local communities in developing countries for generations and have come to be Generally Regarded as Safe (GRAS) by the indigenous people. Besides, food is "a defining characteristic of our identity and culture, and an important element, if not the centre, of many of our social activities" (Gkogka, 2019). Hence, indigenous foods and beverages represent the cultural identity of the people that should not be eroded by advances in food processing and packaging but rather complemented.

This is evidenced by the official recognition of the Mediterranean Diet as an Intangible Cultural Heritage of Humanity by UNESCO Intergovernmental Committee in 2010. Needless to say, that Africa whose food systems are characterised by indigenous cultural practices is an abode of several cultural foods and practices that could be accorded world cultural heritage recognition.

The safety issues that surround the production, distribution and consumption of indigenous beverages/foods in contemporary times is largely due to unhygienic processing and handling occasioned by poor infrastructural development and lack of social amenities provisions that has become the hallmark of developing communities across the globe. Accordingly, Nwaiwu *et al*., (2020) asserted that "a concern which may lead to the microbial contamination of unregulated artisanal local drinks in Nigeria is poor hygiene. Certain organisms have come to serve as indicators; which point to poor hygiene, this can occur at any point during the production or storage of finished products and sales. Around the world, it is an established fact that poor hygiene in developing countries contributes to the proliferation of food pathogens in several local beverages". Therefore, the provisions and improvements in infrastructures in developing countries will lead to a drastic improvement in food safety practices in the production of safe foods irrespective of the origin and cultural practices associated with the production of the food items.

The food supply chains ranging from production, processing, distribution, marketing and consumption in Nigeria and other developing countries are largely based on indigenous knowledge and practices that were handed down from successive generational ancestors. In every culture across the world there remains viable traditional foods and food system that are deeply rooted in the culture and belief of the indigenous people. In most parts of the world, these traditional foods and food systems of the indigenous people have been commercialised to give urban migrants access to and taste of traditional delicacies of their ancestral homeland. In central and northern Nigeria, plant-based beverages are generally known as '*Kunu'*. Hence, there are different types of '*Kunus'* which are classified based on the derivative materials. These include *kunu zaki, kunu gyada, Kunu Aya, kunu akamu, kunu tsamiya, kunu baule, kunu jiko, ashamu* and *kunu gzakimba of which kunu jiko, Kunu Zaki, Zobo, Fura de Nono, Kunu Aya,* and *Kunu Gyada* are the most popular indigenous beverages in Nasarawa State, North Central Nigeria.

Traditional or indigenous foods confer several health benefits; among others. They rely mostly on fermentation and do not require artificial additives and so are less harmful to people and the environment as a whole. Indigenous beverages give consumers; energy, and nourishment, and quench their thirst, especially in restaurants, homes, in different types of schools and institutions (Mohammed and Agha, 2016). They also form cheap sources of special delicacies to mark occasions for different religious folks, festivals, burial, marriage, and child naming ceremonies. Besides their food value, they serve as a source of income generation for the enormous number of both educated and uneducated youths and women. Therefore, expanding the food chain to accommodate indigenous species is an important way to enhance overall human health and well-being and improve food security as they form an important part of people's food intake all over local communities in developing Nations. Beyond their contribution to local food availability, wild indigenous plants that serve as raw materials for the production of indigenous foods and beverages also help maintain cultural diversity (Agulanna, 2020). However, due to poor food safety knowledge and practices, poverty, and illiteracy among producers and vendors of indigenous foods, various unsafe and hazardous food safety practices abound that compromise the nutritional quality of the beverages and pose threat to public health. According to Delia *et al*., (2015) developing countries record well over 80% of food sold is done in informal markets which are largely unregulated and non-transparent, thus prone to activities that might compromise food safety. However, "informal markets are not necessarily dangerous and formal markets are not always safe. Although hazards are common in informal markets, they do not always translate to risk" (Delia *et al*., 2015).

Therefore, as a result of the growing concern related to food safety issues and open-air trading of food through the informal market systems, it is imperative to channel resources and research in the food chain to ascertain the impact and health implications of the consumption of roadside traded ready-to-drink beverages. This is particularly important in developing countries where informal markets and open-air trade of food are predominant and gastrointestinal diseases rank among the top five causes of illnesses, morbidity, and death. Unsafe food is one of the essential contributors to the burden of gastrointestinal diseases in the region (Nwaiwu, *et al.*, 2020).

Kunu-Zaki is a traditional non-alcoholic millet/sorghum-based fermented beverage indigenous to Northern Nigeria but consumed among the various ethnic groups in the country. The typical ingredients for *Kunu Zaki* production include millet or sorghum, malted rice, and spices such as ginger, pepper, and cloves (Abulude, *et al.*, 2006; Ashiru, *et al.*, 2003).

Zobo drink is a popular homemade beverage in Nigeria that is prepared from the *Hibiscus sabdariffa* plant. The beverage is made by extracting the juice from the rosella leaf which is a characteristically intense red colour using hot water. It is usually sweetened with sugar or fruit extracts such as pineapple and cloves before serving. It is loved and consumed by many people for its ability to quench thirst, stimulating effect, and nutritional value. In fact, it is considered a healthier alternative to some commercial carbonated soft drinks for health and nutrition-conscious Nigerians. Unfortunately, *Zobo* deteriorates quickly if prepared and not consumed immediately, due to varieties of factors such as processing method, contamination from the sorrel calyces, ingredients and poor-quality water used for production, and lack of personal hygiene from the home producers resulting in microbial contamination (Bristone *et al*., 2018).

Fura da nono (millet cereal and fermented milk) is a highly nutritious beverage consumed often in northern Nigeria. The nutritional values of the ingredients involved in mashed millet (*fura*) include carbohydrates essential for energy and that of milk or yoghurt (*nono*) includes proteins that are essential for growth and bodybuilding. Traditionally *fura da nono* is usually prepared by mashing millet into powdery form and mixing with spices and hot water to make dough, allowing the dough to cool and solidify and finally mixing the mashed millet (*fura*) with fermented milk (*nono*). The preparation of *fura da nono* from grain grinding to blending of *fura* with milk and other ingredients is by and large a traditional process passed on from one generation to another rather than a science-based procedure. Thus, the process is a simple process that typically employs traditionally-available utensils such as calabash, mortar, and pestle under limited hygiene practice or no hygiene precautions at all. In addition, environmental parameters such as temperature, relative humidity, and poor air quality could as well negatively affect the quality of *fura da nono*. Moreover, the poor hygienic conditions under which *fura da nono* is sold could make the product vulnerable to microbial contamination. Similar to the fermentation of most locally-produced fermented foods, the process of *fura da nono* fermentation is not only uncontrolled but unmonitored, particularly with respect to the duration and product quality. Thus, the production of undesirable fermentation by-products and contaminations is not checked (Yusuf *et al.*, 2020).

Kunun/Madaran aya (Tigernut Milk) is one of the most widely consumed Nigerian vegetable milk after soybean milk (*Madaran waken suya*), followed by cocoa nut milk extract (*Madararan koko*). The interest in tiger nut milk also known as *Kunun-Aya*, has increased over the years possibly because of its sensory, nutritional and probiotic prospects. *Kunun aya* beverages are made from the extract of tiger nuts.

The consumers of this product believe that *Kunun aya* gives them ability to withstand extremely cold condition in the rain when farming and inside Cold River when fishing. Other benefits also include the smoothening of skin wrinkles usually caused by ageing or fatigue (Bristone *et al*., 2018).

Kunun gyada is one of the most important home-prepared and street-vended drinks. It is also taken as a complimentary breakfast cereal drink by all classes of children and adults. It is used extensively during fasting periods, ceremonies, school feeding, and the management of people with health problems. The mode of preparation may differ significantly depending on its intended uses, which also helps to create varieties of *Kunun gyada* (Bristone *et al*., 2018). Despite the wide acceptance these beverages have enjoyed and the concerns about the crude processing and post-processing procedures, not much is known about the food safety and nutritional qualities of the products in the study area as regards the informal marketing system.

MATERIALS AND METHOD

The Study Area

The research study was carried out within Lafia, an administrative and metropolitan capital of Nasarawa state, Nigeria. It is the major gateway that connects the Northern part of Nigeria with its Southern counterpart and hence a popular spot for road vended foods.

Sample Collection

Fifty-five (55) samples of *Kunu Zaki, Zobo, Fura de Nono, Kunu Aya, Kunu Gyada* were obtained from street hawkers randomly irrespective of their flavour, appearance, and hygiene from various open markets within the metropolis (Figure 1). The samples were collected in sterile sampling polythene bags and were immediately transported to the Animal Science laboratory, Faculty of Agriculture, Nasarawa State University Lafia campus, Nigeria.

Analyses

The beverages were analysed for proximate, physiochemical, and micronutrients (Ca, Fe, Zn, Ca, and Mg) using the methods described by AOAC (2010). Samples were analysed microbiologically using standard methods described by Cheesbrough (2005) and Sharma (2009). Isolates were characterized according to the methods of Sharma (2009).

Colony count was done using a digital colony counter for bacteria and a hand lens for fungi. The total colony was expressed as colony-forming units' in millilitres (Cfu/ml). Fungal colonies were identified colonially using characteristics such as pigmentation on the surface and reverse, sporulation, mycelia, and spore arrangement microscopically (Fawole and Oso, 2007). Bacteria and yeast were identified colonially, microscopically and in a few biochemical tests (Cheesbrough, 2005; Sharma, 2009). The resulting data were analysed using analysis of variance (ANOVA) to establish significant differences among samples.

Figure 1. Informal Market in Lafia-Nigeria: Open-air trading with food and beverages displayed on a dusty road.

RESULTS AND DISCUSSION

The result of the Food Safety and Nutritional Quality of Indigenous Beverages vended in Informal Market in Nasarawa State, Nigeria are presented in Table 1 -3. The proximate composition is presented in table 1. The proximate quality of the beverages samples was in the range of proteins (2.10 to 7.31%), ash (0.83 to 1.99%), carbohydrate (3.55 to 23.28%), moisture (66.13 to 85.38%), fat (0.90 to 7.77%). and crude fibre (0.15 to 2.15%) with samples FN having the highest protein content. Samples ZB, KZ, FN, and KA were generally high in moisture content. This is expected as the beverages are generally used for thirst quenching and refreshing purposes. More so, the study area is characterized by very hot weather and excessive loss of fluid (Gaffa *et al.,* 2002). As a result, Northern Nigeria is known for its preference for soft foods with higher moisture content as exemplified by their food choice and preparation in contrast to their Southern counterparts that have a preference for strong foods such as *eba, akpu,*. Similar studies conducted in southern Nigeria reported lower moisture content (Asuquo *et al*., 2017) proving local beverages in the region to be more viscous. Besides, higher moisture content signified adulteration for cheaper sales and profit maximization, especially among economically disadvantaged persons that are interested in thirst quenching and satisfying hunger rather than nutrition. The protein content of the beverages was observed to be high in KA (7.31%) followed by FN (6.34%) and lowest in ZB (2.10%). Low protein recorded in some of the beverages may be due to their source ingredients and processing methods that may lead to loss of protein especially in beverages that involved the use of cereal in which the protein and other essential nutrients are concentrated in their germs and tasta which are often sifted away during processing. Sample KA recorded the highest ash content (1.99%). These values agree with the finding of Ofudje *et al.,* (2016).

Table 1. Proximate Composition of Indigenous Beverages vended in Informal Market of Nasarawa State, Nigeria (%)

	ZB	**KN**	**FN**	**KG**	**KA**
Moisture	85.38^{cd}±1.13	79.25^{b}±1.25	79.32^{b}±0.89	66.13^{a}±2.63	81.05^{c}±0.55
Crude protein	2.1^{a}±0.05	5.89^{c}±0.06	6.34^{c}±0.34	4.55^{b}±1.09	7.31^{d}±0.19
Crude Fat	0.89^{a}±0.02	0.99^{a}±0.14	7.77^{d}±0.09	2.78^{b}±0.18	5.08^{c}±0.11
Crude fibre	0.33^{a}±0.03	1.89^{c}±0.11	0.15^{a}±0.05	1.04^{b}±0.06	1.03^{b}±0.20
Ash	0.83^{a}±0.45	1.02^{a}±0.04	1.23^{b}±0.23	1.13^{b}±0.14	1.99^{c}±0.01
Carbohydrate	10.48^{c}±1.26	10.99^{c}±1.03	5.21^{b}±0.23	23.28^{d}±3.63	3.55^{a}±0.45

Results are the means of three replications. Mean values with same superscript in a column are not significantly different (p≥ 0.05).ZB = Zobo; KZ = Kunu Zaki; FN = Fura da nono; KG = Kunnu Gyada; KA = Kunnu Aya

Table 2 shows the physiochemical quality of the beverage samples. The PH values varied from 4.22% to 5.53% with KG recording the highest. Titrable Acidity range from 0.025 to 5.85 with KZ having the highest value. Total soluble solids were within the range of 0.485 to 10.36% with KA having the highest value. The Total Solid range had a range of 8.85 to 20.58% with FN being the highest. The pH of the beverage samples showed them to be acidic. This condition may account for the lower proliferation of spoilage and pathogenic organisms as they do not thrive easily in acidic mediums.

The pH values were lower than that reported by Braids *et al.,* (2018) and higher than the study of Onyemekara *et al.,* (2018) but similar to that reported by Ofudje *et al.,* (2016). The acidity value of KN was the highest (5.85%) among all the beverages. This could be attributed to the added species and also to the presence of some microorganisms such as *Lactobacillium, Acidophillus, Candida* species, and *Saccharomyces cerevisiae* which help in acid formation in indigenous beverages that employ uncontrolled wide fermentation and are essential to humans as reported by Ofudje *et al*., (2016). The value of the total solids was higher than that reported by Ofudje *et al*., (2016).

Table 2. Physiochemical Properties

Parameter	**ZB**	**KZ**	**FN**	**KG**	**KA**
pH	5.17^{a}±0.63	4.48^{a}±0.19	4.94^{a}±0.07	5.530^{a}±0.100	4.22^{a}±0.25
TTA	2.06^{b}±0.08	5.85^{c}±0.15	1.74^{b}±1.18	0.025^{a}±0.005	0.953^{ab}±0.07
TSS	6.51^{b}±0.06	5.59^{b}±0.01	9.78^{c}±0.22	0.485^{a}±0.035	10.36^{c}±0.16
TS	8.85^{a}±0.09	10.01^{ab}±0.23	20.58^{c}±1.02	11.160^{ab}±0.18	19.54^{c}±1.00

Results are the means of three replications. Mean values with same superscript in a column are not significantly different (p≥ 0.05).ZB = Zobo; KZ = Kunu Zaki; FN = Fura da nono; KG = Kunnu Gyada; KA = Kunnu Aya TTA = Titrable Acidity; TSS = Total Soluble Solid; TS = Total Solid

The micronutrient composition is shown in table 3. The micronutrient result show Ca (3.37 to 46.57mg/ml), Fe (0.47 to 45.67 mg/ml), Zn (0.35 to 34.87), and Mg (1.84 to 23.34mg/ml). Samples FN had the highest calcium (46.57mg/ml) and KZ had the highest Fe (45.67mg/ml), Zn (34.87mg/ml), and Mg (23.34mg/ml). The sample KZ's high mineral content could be attributed to the input materials of mixed herbs/species, malted cereals, and the fermentation processes employed in its production. Calcium, Magnesium, Iron, and Zinc are essential minerals required by the body in different quantities. Ca is crucial in promoting the deposition of hydroxyapatite in bone and serve the mechanical roles of strengthening bones and teeth, it supports the functions of excitable tissues, including nerves and heart muscles, as well as blood clotting (Aspray, 2017).

Fe is an essential nutrient supporting oxygen binding and transport, it is necessary for DNA synthesis and cellular proliferation. Due to these key roles, deficiency of Fe is manifested as anaemia, leading to reduced work capacity, impaired mental function, and lowered immunity. However, iron loading due to primary or secondary hemochromatosis can produce liver damage, leading to fibrosis, cirrhosis, and an increased risk of hepatic cancer (Wessling-Restick, 2017). Zn and Mg have been established as essential for health and nutrition especially in growth enhancement and enzyme-substrate interaction respectively. Therefore, the mineral values in this study showed the potential of indigenous beverages in resolving hidden hunger.

Table 3. Mineral Contents (mg/l)

Parameter	ZB	KZ	FN	KG	KA
Ca	3.380^{a}±0.385	16.895^{d}±0.445	46.57^{e}±0.680	11.64^{c}±1.040	6.03^{b}±0.140
Fe	1.135^{ab}±0.005	45.665^{c}±1.345	2.155^{b}±0.605	0.465^{a}±0.025	0.755^{a}±0.055
Zn	2.325^{b}±0.075	34.865^{c}±0.885	0.630^{a}±0.060	0.355^{a}±0.190	0.670^{a}±0.010
Mg	7.625^{b}±0.375	23.340^{d}±0.78	5.075^{ab}±0.125	15.395^{c}±0.445	1.84^{a}±0.170

Results are the means of three replications. Mean values with same superscript in a column are not significantly different (p≥ 0.05). ZB = Zobo; KZ = Kunu Zaki; FN = Fura da nono; KG = Kunnu Gyada; KA = Kunnu Aya

The microbial safety of the beverages is presented in Tables 4 and 5. The Microbial profile shows that the total plate count ranges from 3.33 x 10^5 cfu/g for sample KA, 7.88 x 10^3 cfu/g for sample ZB, 6.02 x 10^7 cfu/g for sample KZ, 7.13 x 10^5 cfu/g for sample FN, and 4.62 x 10^2 cfu/g for sample KA respectively. The fungi count ranges from 3.81×10^3 cfu/g for sample ZB, 5.04 x 10^6 cfu/g for sample KZ, 1.72 x 10^5 cfu/g for sample FN, 1.72 x 10^2 cfu/g for sample KG, 2.43 x 10^3 cfu/g for sample KA. The Coliform count ranges from 4.94 x 10^3 cfu/g for sample ZB, 6.84 x 10^8cfu/g for sample KZ, 7.08 x 10^6cfu/g for sample FN, 2.61 x 10^2cfu/g for sample KG, 4.60 x 10^4cfu/g for sample KA.

The microbial result of the beverages samples revealed varying degrees of microbial contamination with some samples (ZB, KG, and KA) showing an acceptable level of microbial load of < 10^4 cfu/g but the total coliform count exceeded the recommended safe level (< 100 coliform/g). The Total Viable Count is an indicator of quality, not safety, and cannot directly contribute towards a safety assessment of ready-to-eat food but can be used as part of a general quality assessment including that of extended shelf-life foods (Eke and Elechi, 2021). Microbial criteria regulation varies across countries.

ICMSF, (2006) considers TVC in the range of 0-10^3 cfu/g, 10^4-10^5 cfu/g, and >10^6 cfu/g as acceptable, marginally acceptable (tolerable), or unacceptable respectively. On the other hand, UK Health Protection Agency (2009) and FSANZ, (2001) are more stringent stating that RTE foods with TVC exceeding 10^5 cfu/g are of objectionable quality and therefore unfit for consumption. Based on the microbiological standards used, the indigenous beverages sold at the informal market of Nasarawa State – Nigeria were deemed acceptable for sale with the exception of KZ which recorded significantly above 10^5.

Some consumers of KZ (Kunnu Zaki) have reported cases of gastrointestinal disorders after consuming the beverages. This disorder could be attributed to the unhygienic processing and packaging of the products, especially with the tradition of the reuse of used pet bottles as packaging materials. Also, the characteristic flavour of Kunun Zaki as a result of the fermentation process makes a favourable substrate for houseflies' patching and contamination. This has made many consumers of these beverages patronise homemade Kunun Zaki by vendors with perceived good personal and food hygienic practices. The microbial counts were lower than that reported by Braids *et al*., (2018) but higher than that reported by Onyemekara *et al.,* (2018).

Table 4. Microbial Profile CFU/l

Parameter	ZB	KZ	FN	KG	KA
Total Viable Count	$7.88 \times 10^3 \pm 120^b$	$6.02 \times 10^7 \pm 130^d$	$7.13 \times 10^5 \pm 150^d$	$4.62 \times 10^2 \pm 280^a$	$3.33 \times 10^5 \pm 900^c$
Total Coliform Count	$4.94 \times 10^3 \pm 600^b$	$6.84 \times 10^8 \pm 160^d$	$7.08 \times 10^6 \pm 290^c$	$2.61 \times 10^2 \pm 65^a$	$4.60 \times 10^4 \pm 200^{ab}$
Total Fungal Count	$3.81 \times 10^3 \pm 600^c$	$5.04 \times 10^6 \pm 259^e$	$1.66 \times 10^5 \pm 105^d$	$1.72 \times 10^2 \pm 26.5^a$	$2.43 \times 10^3 \pm 130^b$

Results are the means of three replications. Mean values with same superscript in a column are not significantly different (p≥ 0.05). ZB = Zobo; KZ = Kunu Zaki; FN = Fura da nono; KG = Kunnu Gyada; KA = Kunnu Aya

The microbial isolate from the beverages included *Staphylococcus aureus, Pseudomonas, Klebsiella species Bacillus species, Lactobacillus acidophilus, and Saccharomyces cerevisiae* some of which are of food spoilage and food poisoning significance as shown in table 5. This is not surprising as most of the isolates are secondary micro-flora of fermentable food products. Most of the indigenous beverages such as *Kunnu Zaki*, *Zobo*, and *nono* undergo fermentation within a short time (24-48 h) after production if kept at room temperature of between 40-45^{o}C (Nwaiwu *et al.*, 2020).

Despite the acidic nature of the beverage samples, the survival of bacteria in the drinks is worrisome. The survival of both pathogenic and food spoilage microorganisms in spite of the low pH could be attributed to post-processing and marketing contamination as most of the vending points and vendors lack sanitary and hygienic practices. A comparison between freshly processed and street-hawked *kunu* (Amusa and Odunbaku, 2009; Nwaiwu *et al.*, 2020) showed that the fresh samples were free of coliforms whereas products found on the street were not. This shows that indigenous beverages due to their open-air trading systems are very susceptible to post-process contamination.

The bacteria genera namely *Bacillus, Escherichia, Lactobacillus, Staphylococcus, and Streptococcus* were detected in all five beverages. It is worrisome that the three most prevalent bacteria are *Bacillus*, *Escherichia*, and *Staphylococcus*. These species are known hygiene indicators and suggest very poor hygienic conditions during the preparation and storage of beverages such as the use of unsafe water, cruel processing methods, and unhygienic display and vending environment. *Staphylococcus* is widely distributed in nature and is a part of normal flora among humans, animals, plants, and the environment; hence the possibility of food contamination with the genus is very high. *Lactobacillus* species is non-pathogenic and acid fermentation of *Kunnu* and *Nono*. Its production of lactic acid increases the acidity of the beverages thereby retarding the activities of pathogenic organisms for the microbial safety of the drinks (Onyemekara *et al.*, 2018). In particular, the roles of *Escherichia* and other *Enterobacteriaceae* as hygiene markers are well-reported (Buchanan and Oni, 2012) and high counts of these species mean that the food or drink did not follow normal food safety procedures. The concern is that the hygiene indicator organisms could also be pathogenic. However, there were no tests to confirm whether the *Bacillus* species observed were pathogenic *B. cereus or B. subtilis*, which could have probiotic potential. Additionally, a confirmation assay to determine if the *E. coli* strain found was the shiga toxin-producing E. coli O157:H7 or other E. coli serotypes with pathogenic potential was not carried out. It has been reported that the microorganisms associated with unhygienic processing conditions are mainly environmental contaminants with a few of faecal origin (Martin *et al.*, 2016). Hence, it can be concluded that most of the indicator organisms found in this study were due to process contamination and they may not be pathogenic strains.

Fungi are natural flora of the soil with their acid-tolerant spores easily spread by air, hence a common contaminant of cereal, legumes, and natural spices and herbs used as raw material in the production of indigenous beverages. Therefore, the fungi genera *Saccharomyces, Aspergillus, Candida, Penicillium, and Fusarium* were found in all the beverages. The presence of *Saccharomyces* is expected because it is known as a dominant organism in many beverage fermentations. There are no immediate concerns for adverse toxic metabolites from *Saccharomyces* fermentation but the risk could exist due to methanol production when the product is distilled into gin (Ohimain, 2016).

The occurrence of three fungal genera, namely *Aspergillus, Penicillium,* and *Fusarium,* which are responsible for producing the majority of the mycotoxins that are toxic to humans, animals, and plants (Ismaiel and Papenbrock, 2015) may mean that post-production tests of the beverages are required to assure food safety. The problem regarding the resources required to perform molecular characterizations contributed to the minimal investigation of the pathogenicity of microorganisms isolated in the beverage samples.

Table 5. Microbial Isolates

Parameter	**ZB**	**KZ**	**FN**	**KG**	**KA**
Bacterial	*Bacillus Enterobacter Lactobacillus Micrococus Salmonella Staphylococcus Streptococcus Pseudomonas*	*Bacillus Lactobacillus Staphylococcus Streptococcus Pseudomonas*	*Bacillus, Escherichia Enterobacter, Klebsiella, Staphylococcus Salmonella Streptococcus Pseudomonas*	*Bacillus, Escherichia Lactobacillus Salmonella Staphylococcus Streptococcus Pseudomonas*	*Bacillus, Escherichia Lactobacillus Salmonella Staphylococcus Streptococcus Pseudomonas*
Mould/fungi	*Aspergillus Penicillium Fusarium*	*Saccharomyces Penicillium*	*Aspergillus, Candida, Saccharomyce Penicillium*	*Aspergillus Penicillium*	*Aspergillus, Candida, Saccharomyce Penicillium*

ZB = Zobo, KZ = Kunu Zaki, FN = Fura da nono, KG = Kunnu Gyada, KA = Kunnu Aya

CONCLUSION

Despite the sector's contribution to the food and nutrition security of the country, ready-to-eat food traded in Nigeria's informal marketplaces is mostly uncontrolled. While the consumption of street meals that fall short of the minimum safety standard is harmful to health on an acute or ongoing basis, it has a beneficial influence on food security when they are healthy and nutritious. As a result, all of the samples of indigenous drinks were suitable for human consumption and nutritionally viable. Most of the beverage samples' microbial counts fell within acceptable ranges as per national and international norms and regulations.

The information provided here serves as a starting point for future quantitative risk assessments. The quality and safety of street food will be significantly increased, though, by providing basic facilities and educating the food vendors. Regulation, efficient monitoring, and execution of the current punitive measures are therefore advised to ensure the constant trading of safe and nutritious food for the general well-being of the indigenous people.

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Assessment of Global Warming on Food Production in Afghanistan

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Abstract

Global Warming is taking its toll on Afghanistan. Over the past fifty years, rising temperatures and dropping precipitation levels have resulted in a variety of meteorological anomalies that have caused droughts, floods, unseasonal precipitation, falling ground water tables, desertification, and a decline in biodiversity. Additionally, the impact of Global Warming on food security is significant. The climatic changes brought on by Global Warming have a profound impact on food supply chains, food habitats, and food systems in general. These modifications have effect on food production, storage, processing, marketing, availability, promotion, affordability, and quality along the food value chain. More than simply agricultural productivity will need to be taken into consideration in order to adapt food systems for the improvement of food security for the poor and vulnerable and to avert future negative effects of Global Warming. It is projected that further change in climatic conditions will take place over the coming decades, and its effects on Afghans' quality of life and ability to support their families have already been considered as detrimental. Due to their heavy reliance on agriculture for survival, rural residents in Afghanistan are among the most susceptible to the effects of Global Warming among all population groups.

Keywords: Global Warming, Food production, Droughts Afghanistan

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INTRODUCTION

Increasing the necessary studies and measures to minimize the emissions of carbon emissions should be taken all over the world and measures that will minimize the greenhouse gas effect will play an important role in reducing the effects of global warming (Bağdatlı and Arıkan, 2020).

Global Warming involves variations in temperature and precipitation across the globe. The food supply chains, food environments, and food systems in general are significantly impacted by the environmental changes brought on by Global Warming. Along the food value chain, these changes have an impact on food production, storage, processing, marketing, availability, promotion, affordability, and quality (Sarwary et al., 2020).

World effects of global warming caused by changes in the climate system of the highest peaks, ocean depths, is felt throughout much of the world from the equator to the poles. The polar ice caps are melting, sea level is rising and soil losses are experienced in coastal areas. Sea level due to melting of glaciers Increasing the temperature rose from 10 to 20 centimeters (Bağdatlı and Bellitürk, 2016a).

Through direct and indirect effects on crop growth, Global Warming will affect food production. Modifications to precipitation, temperatures, and carbon dioxide availability are examples of direct effects. The advent of invasive species, changes in pest and disease profiles, soil erosion, effects on the availability and seasonality of water resources, and declines in arable land owing to desertification and land degradation are only a few examples of indirect consequences. Even on lower emission pathways, these effects are predicted to harm major agricultural production on a global scale. (Tebaldi et al., 2018). Increasing world population, changing climate conditions and economic activities are growing with each passing day makes it more important than water (Bağdatlı and Bellitürk, 2016b).

As a result, Global Warming or climate change has an impact on food security globally and on people's income, particularly in developing nations where rain-fell on agriculture predominates and makes food systems extremely vulnerable to changes in temperature and rainfall (Sarwary et al., 2020). Food security is significantly hampered by Global Warming or climate change. More than simply agricultural productivity will need to be taken into consideration when adapting food systems to improve food security for the poor and vulnerable and to avert future adverse effects from Global Warming or climate change. (Ziervogel, 2010). Afghanistan is mountainous and semi-arid country that experienced three decades of conflict. Due to its extremely limited ability to deal with the effects of Global Warming, it is one of the most vulnerable nations in the world. In recent years, it has been evident that climate change is a universal phenomenon that will affect many aspects of society, including agricultural and food systems, notably in Afghanistan (Tumwesigye et al., 2019). Afghanistan is particularly susceptible to decreased food production brought on by glacier retreat, floods, droughts, unpredictable rainfall, and other effects of climate change. As a result of poor infrastructure, instability that prevents national efforts at mitigation, and a lack of resources to organize against the negative effects of Global Warming on livelihoods, these nations as well as the poorest ones like Afghanistan are likely to be most negatively affected (Parto, 2014). Climate change has become the focus of constant attention of living things and civilizations take into account the climatic parameters determined their lifestyles. Climate increasing or decreasing in changes affect living things negatively. Decrease in productivity, especially in agricultural production causes (İstanbulluoğlu et al., 2013). Global climate change affects the world negatively day by day and reveals negative results in agricultural product yield. In particular, it is inevitable to evaluate the regional temperatures and to review the product pattern in parallel with the increasing global climate change (Bağdatlı et al., 2014).

HUMAN HEALTH AND NUTRITION

Without adaptation, the danger of hunger and child malnutrition on a worldwide scale might rise by 20% by the mid-2050s, according to the World Food Program. (World Bank Group, 2015). Evaluated the likelihood of excess, climate-related mortality brought on by malnutrition (Springmann et al., 2016). The scarcity of fruits and vegetables in diets and the rising prevalence of people who are underweight are two major risk factors that the authors identified as the primary drivers. According to the forecasts, by the mid-2050s, Afghanistan might see 40.8 climate-related deaths per million people connected to a lack of food (at present day population-levels this represents approximately 1,400 people). The additional nutritional effects of climate-related disaster events, which harm food production systems and economic conditions, are not considered. Additionally, stunting is substantially more common in Afghanistan among children from families with poorer incomes and/or less diverse diets. (Kim et al, 2017).

Children in rural parts of Afghanistan are probably more at risk of stunted growth and the severe long-term health repercussions that go along with it since the expected increase in drought probability and average temperatures may limit agricultural productivity (World Bank Group 2015).

GLOBAL WARMING AND FOOD SECURITY

"Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that fits their dietary needs and food preferences for an active and healthy life," says the Food and Agriculture Organization. (Schmidhuber et al., 2007; Stamoulis et al., 2003). This concept includes four essential aspects of food supplies: accessibility, stability, usability, and availability. Food sufficiency, or the system's overall capacity to meet demand for food, is referred to as availability. Stability refers to people who face a significant risk of losing their access to the resources required to obtain enough sustenance, either temporarily or permanently. The third aspect of food security is access by individuals to enough money to buy appropriate food for a nourishing diet. Utilization, the last dimension, includes all of nutrition's sub dimensions as well as the issues of food safety and quality. Three of the aforementioned factors affecting food security availability, access, and utilization are well-recognized in the literature (Burke et al., 2010).

Maintaining the factors that determine the possible impacts of Global Warming on food security requires an awareness of the factors that determine availability, access, and consumption of food as well as how each factor may be impacted by climate change. While these authors investigate the effects of Global Warming on these three pillars. (Schmidhuber et al., 2007). Include stability in their study of impacts as well. Agribusiness output is closely related to food supply, which makes it vulnerable to the effects of climate change. Increased atmospheric carbon dioxide concentrations, which will improve crop-growing conditions in some areas, the likelihood of intensified pest and disease issues leading to crop losses, drier conditions and increased water stress affecting crop yields are some of the common mechanisms through which global warming can affect agriculture (Fischer et al., 2002).

Agricultural production and potential planted areas could be significantly impacted by climate change. Global food trade will operate as a potential buffer when nations trade and when Global Warming shocks are not evenly distributed across space, thereby lessening the negative effects (Burke et al., 2010). Depending on the scenarios projected, the increase in temperature in temperate latitudes is anticipated to primarily benefit agriculture by expanding the areas that may be suitable for farming and lengthening the growing season, which will increase crop production. (Schmidhuber et al., 2007). In some humid and temperate grasslands, this may also boost pasture yield and lessen the requirement for housing and compound feeding. However, it is expected that decreased livestock productivity and increased animal mortality will occur in semi-arid and arid regions (Adger, 2007). Additionally, higher evapotranspiration and decreased soil moisture in drier regions are predicted by climate models, which may make certain cultivated areas unfit for cropping and some tropical grasslands more arid. Additionally, warmer temperatures are probably going to widen the range of many agricultural pests and improve their capacity to survive the winter and damage spring crops (Adger, 2007). As the soil temperature decreases, plants that are not suitable for climatic conditions and resistant to cold will be affected by root and cause drying. As a result, a constantly increasing soil temperature will adversely affect plant life. It will decrease the efficiency (Bağdatlı and Ballı, 2020).

The decrease over time of the changes in the surface of the water is noticeable. This also shows itself as the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change (Albut at al., 2018).

Gradually decreasing rainfalls due to climate changes endanger the living habitat. As a precaution, precise solutions are needed to reduce carbon dioxide in the air and slow down global warming and eventually end it. In this way, greenhouse effect and global warming can be prevented (Bağdatlı and Can, 2019).

The frequency and severity of extreme occurrences like cyclones, floods, hailstorms, and droughts are predicted to rise, making global and regional weather conditions more unpredictable than they are now. This can have a negative impact on the stability of food supplies because it can lead to greater swings in crop yields and local food supply as well as a higher danger of landslides and erosion damages (Schmidhuber, 2007).

Many of the regions where these effects are anticipated to be seen are in sub-Saharan Africa and parts of South Asia, According to Thomson (2003). This suggests that the areas with the greatest levels of chronic undernourishment will also experience the greatest levels of food production instability (Burke, 2010). Argue that "assessing the role of Global Warming in relation to four basic questions: how households earn their income, the nature of their exposure to food prices, how well integrated their local food markets with global markets, and their broader longer-run prospects for livelihood improvement" will help determine the effects of Global Warming on a given household's access to food. Global Warming could have a variety of effects on a household's ability to get food, depending on its income source. In emerging countries, agriculture provides a sizable portion of the income for rural households. The degree of this dependency increases with family wealth. A decrease in agricultural output raises the possibility of negative consequences on family finances and standard of living (Carletto et al., 2007).

Changing climate conditions will be an important factor in the current situation and the problems that may arise in the coming years. For this reason, solutions are needed for global warming and reduction of greenhouse gases that cause climate change (Bağdatlı and Arslan, 2020). The increase in the impact of global climate change will cause global water crises between countries. Necessary measures and measures should be taken in advance to reduce the impact of global climate change (Bağdatlı and Arslan, 2019).

In the coming decades, how these societies live is likely to be significantly influenced by climate change. Although the primary function of food is to provide dietary energy, and commonly used indicators of undernourishment, like those of the FAO, heavily relied on estimation of calories for consumptions in order to estimate food security trends, food also provides protein and other nutrients that are essential for bodily functions. (Burke et al., 2010). It is becoming increasingly clear that inadequate consumption of these nutrients contributes significantly to infectious disease-related morbidity and death worldwide (Black, 2003).

There are three main ways that Global Warming may have an impact on the consumption of micronutrients: "by altering the yields of significant crop sources of micronutrients, by changing the nutritional content of a particular crop, or by influencing decisions to grow crops of different nutritional value" (Burke et al., 2010).

In reaction to the effects of Global Warming, farmers can also change their crop choices, which might alter the availability of micronutrients. (Rosenzweig, 1992; Mihran, 2011). Afghanistan's largest and most significant industry is agriculture, which is owned or managed by more than half of all households. Permanent pastures make up 46% of the total land area, which is 652 thousand square kilo meters, whereas only about 12% of that area is thought to be arable (Hassanzoy, 2009). The poorest populations in Afghanistan, such as small farmers and livestock keepers, will be the most exposed to the effects of Global Warming since they are the least equipped to adaptation strategies, according to (Savage et al., 2009). Other groups, such sedentary farmers and nomads, are less susceptible because they may relocate to find new pastures.

Casual workers and government employees are also impacted, though less severely because their means of support do not (directly) depend on it. Pressure on small holding farmers in rural areas is projected to increase due to the Kuchi populations' increased process of settlement as a result of extended and frequent droughts, as well as the possibility of rising temperatures and lower-than-normal rainfall. In Afghanistan, most women do not engage in paid economic activities. They heavily rely on the male family members for financial support or on their own labor on their meagre allotments of land to grow food. Women and children from low-income families are therefore among those who are most exposed to the effects of Global Warming that threaten traditional ways of life. Nearly 11 million Afghans, or 36% of the country's population, live below the poverty line. (Kumar, 2013) unable to satisfy dietary needs and necessities. Malnutrition and food insecurity are both problems in cities. Due to its extreme poverty, Afghanistan was more severely impacted by the 2007–2008 food price crisis than other nations. Overall, about 27.7% of people experience a crisis regarding their ability to access food (Frankenberger, 2011). With an average yearly per capita consumption of over 200 kg, wheat is the primary food crop that provides roughly 60% of the caloric intake for an ordinary Afghan (440 pounds) (Persaud, 2012). The primary basic grain grown in Afghanistan is wheat. Wheat accounts for 94 percent of all crops grown on rain-fed land and 77 percent of all crops grown on irrigated land (Mihran, 2011). The ability to produce food has an impact on its accessibility in rural regions and is the foundation for local farmers' ability to make a living. Afghanistan has never been self-sufficient in wheat, despite producing 96.6 percent of the wheat used in 2009 due to extraordinarily unfavorable weather, and its wheat production levels have fluctuated greatly throughout the years (Sharma et al., 2015). Rice, barley, maize, and pulses are examples of other grains. Other fruits and vegetables grown by farmers include potatoes, onions, tomatoes, okra, cauliflower, melons, watermelons, apricots, almonds, pomegranates, apples, and grapes. (Mihran, 2011).

CONCLUSION

The global warming or climate change have a profound impact on food supply chains, food habitats, and food systems in general. These modifications have effect on food production, storage, processing, marketing, availability, promotion, affordability, and quality along the food value chain. On the other hand, Global Warming have started showing its impact on agricultural yield and food worldwide. Food securities are threatened, especially in arid and semi-arid areas will further decline. The present situation in most of the arid and semiarid countries is not satisfactory. These countries are not able to fulfil the required demand of food for people. Afghanistan is one of mountainous and semi-arid country. Due to its extremely limited ability to deal with the effects of Global Warming, it is one of the most vulnerable nations in the world.

Afghanistan is particularly susceptible to decreased food production brought on by glacier retreat, floods, droughts, unpredictable rainfall, and other effects of Global Warming. Therefore, more than simply agricultural productivity will need to be taken into consideration in order to adapt food systems in order to improve food security for the poor and vulnerable and to avert future negative effects of Global Warming.

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Combined Effects of High-Pressure Processing and Marination on The Quality of Herring (*Clupea harengus*) Fillets

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Abstract

In this study, it was focused on the combined effects of marination and high pressure processing (HPP) treatment on herring fillets. For this purpose, herring fillets were marinated with 3% acetic acid and 6% NaCl solution at 4ºC for three days. After ripening process marinated fish samples were vacuum packaged and treated with HPP in different pressure levels (100, 300, and 500 MPa) and pressure holding times (5 and 10 min.). One group was left untreated as control. All samples were stored at 4±1ºC for 90 days. During the storage, pH, TVB-N and TMA-N values were assessed. According to results the samples treated with 300 and 500 MPa showed lower results than the groups treated with 100 MPa and the control. Moreover, 500 MPa HPP treatment had the best effects on the maintaining the quality of marinated herring. It can be concluded that HPP treatment can be used to preserve good quality of marinated fish for long term storage.

Keywords: Marination, non- thermal processing, high pressure processing, fish quality

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INTRODUCTION

Fish demand is increasing worldwide, mostly people in developing countries consumed fish to complete their protein needs (James, 1986). Fish is a perishable product which inclined it to quickly spoil through microbes. Some basic reasons which help quick propagation of microbes known as lipid contents, less collagen and relatively high quantity of soluble nitrogen composites in the muscle. After fish death many biochemical variations occurred in fish muscle due to activity of endogenous enzymes. Many proteases like peptidases and cathepsins used for breakdown of muscles protein during post-mortem storage of fish (Sherekar et al., 1986; Sicbert, 1958). Fish and other seafood can be preserved for long time by using different methods such as salting, drying, smoking, freezing and marination. Immediately after harvesting fish can be marinated for enhancing storage and transportation time. Marination is an oldest common method of fish preservation in Europe. "Marinade" is a term which is used for fresh, freeze whole fish or fish pieces after treated by salt, sauces, oil and placed into brines. Eatable natural acid, mostly acetic acid is also used for fish marination (Meyer, 1965).

During marination salt and Acetic acid are used to stop the activity of enzymes and microbes and also improve the taste of fish with prolong shelf life (Meyer, 1965; Mc Lay, 1972). Fish can be semi-preserved through marination which is eatable without cooking and required only little preparation before serving (Fuentes et al., 2010).

Due to semi preservation they required industrial techniques to extend shelf life for commercial storage of fish. Marination preservation method based on mixture of salt and acetic acid. Smoothness and other physical properties of marinated fish product will be enhanced by appropriate penetration of salts, acids and additional elements (Yashoda et al., 2005). Concentration of salts and acids in marination mixture depends on many aspects involving fish species, fish size, fish weight, lipid content, thickness of fillet and surrounding temperature. Acetic acid and salts used for breakdown of proteins which concluded as stiffness in fish meat and not as much of susceptible to swelling (Shenderyuk and Bykowski, 1990). In this condition fish meat capacity of water holding become less and water from fish flesh discharged into marinating mixture. Some additional components along water including lipids, proteins and minerals drawn-out into the marinating mixture which leads to less weight yield and poor quality of fish product. Techniques which can be used to extend the shelf life of marinated fish product at industrial level for storage and packaging (Ozden and Erkan, 2006; Sallam et al., 2007; Gunsen et al., 2010, 2011; Ucak et al., 2019; Ucak and Gökoğlu, 2020) involve addition of flavors and some plant extracts (Cadun et al., 2008; Sen and Temelli, 2003; Guldas and Hecer, 2012; Kucukgulmez, 2012) and pasteurization (Kılınc and Cakli, 2005).

Advanced non-thermal techniques also used for achieving consumer requirements of less treated foods, including resound technology (Guimaraes et al., 2018), cold plasma (Coutinho et al., 2018), pulsed electric field (Odriozola-Serrano et al., 2013), ohmic heating (Costa et al., 2018), supercritical carbon dioxide (Amaral et al., 2017; Amarala et al., 2018) and high pressure processing technology (HPP) (Figueiredo et al., 2015; Teixeira et al., 2014; Ucak et al., 2018)). High pressure processing is commercially used for pasteurization of food products such as meat, seafood and fruit juices (Medina-Meza et al., 2014). This technique is used to deactivate enzymes and spoiling microorganisms at less temperature with slight modifications in surface consistency, nutrients, taste and color of the product (Smelt, 1998; Thakur and Nelson, 1998; Considine et al., 2008). High-pressure processing is a non-thermal technique used to achieve consumer's requirements of less treated suitable high quality products with original taste (Oey et al., 2008; Patras et al., 2009). The basic target of HPP is bacterial cell membranes (Smelt, 1998), so it interrupts process of chemical permeability which occurred through membrane. Due to this damage cell components transformed to waste, pH change, enzymes become denatured, and eventually lead to cell death (Smelt et al., 2001). In this study it was aimed to evaluate the quality of marinated herring fillets treated with high pressure processing during cold storage.

MATERIAL AND METHODS

Preparation of fish marinade an HPP treatment

Herring (*Clupea harengus*) fillets were provided from fish market in Germany (Quakenbrück). Fish fillets were transported in ice boxes to the laboratory of German Institute of Food Technologies. Then fillets were stored at -20°C until using. For the marination process 3% acetic acid (v/v)+6% NaCl (w/v) solution was prepared in the glass jars. The skins of thawed fish fillets were removed aseptically and rinsed with distilled water. Fish-to-solution ratio was arranged as 1:1.5 (w/v) and fish marinades were placed into glass jars.

The ripening process was performed 4°C for 3 days. The vacuum-packed marinated fish were treated with a high-pressure test system (WAVE 6000/55HT; NC Hyperbaric, Burgos, Spain) possessing a 55-L chamber and a maximum pressure level of 600 MPa. 100, 300 and 500 MPa pressure levels were applied for 5 and 10 min. Control was left as untreated. All samples were stored at 4ºC for 3 months and periodically analyzed.

Analyses

The pH value of the samples was determined by dipping the pH-meter probe into the fish homogenates (1:1, w:v, fish:distilled water). For the determination of total volatile basic nitrogen (TVB-N) the method of Schormuller (1968) was used. The results were expressed as mg nitrogen/100 g sample. Trimethylamine (TMA-N) analysis was performed according to the method of Schormüller (1968).

Statistical analysis

All measurements were carried out in triplicate and data were subjected to Analysis of Variance (ANOVA) and Duncan's multiple range tests using the SPSS Version 18.0 statistical package (SPSS Inc., Chicago, IL, USA). Differences were regarded statistically significant at $P<0.05$.

RESULTS AND DISCUSSION

pH

When fish become spoil due to the activity of microorganisms, some compounds discharge which has bad smell and taste like ammonia and hydrogen sulphide. Due to excretion of these compounds pH of fish sample will be increased (Gennari et al., 1999). High pressure processing reduces existing acidic groups in muscle proteins which causes high level of pH (Angsupanich and Ledward, 1998; Ma et al., 2007).

Herring fillets samples were taken on end of the trial and pH value were observed at 0, 15, 30, 45, 60, 75 and 90 days at 4±1°C. The effect of storage on marinated herring fillets treated with HPP samples pH is given in Table 1. The pH value in herring fillets found increased with storage period and pH value was found highest at day 90 (4.62) as compared to pH at day 0 (4.40) ($P<0.05$). The groups B, C, D, E, F, and G had lower pH values than the control group in all days. The lowest pH value was observed in group G (4.37) followed by F (4.43), E (4.47), D (4.53), C (4.53), B (4.57) and A (4.62) after 90 days of storage. In contrast to our findings Bindu et al. (2013) performed an experiment on *Fenneropenaeus indicus*, who observed that different levels of HPP had significant results ($P<0.05$). It might be opposite to our study because their pH values increased as pressure was increased while in our study G group with highest pressure has lowest pH value. Increment of pH with increasing pressure was also observed in another study on minced albacore muscle. Escalation in pH is occurred because HPP encouraged protein breakdown through unfolding and ionization of protein (Morild, 1981; Yamamoto et al., 1994).

Total volatile basic nitrogen (TVB-N)

Total volatile basic amines (TVB-N) are commonly used process to check the quality of seafood. TVB-N value in herring fillets was observed at 0, 15, 30, 45, 60, 75 and 90 days after storage at 4°C (Table 1). At 0 day, TVB-N value of herring fillets of control group was (17.60 mg N/100 g) and increased in all samples during the storage and at the end of storage on 90th day TVB-N value was found highest (56.70 mg N/100 g) in control group ($P<0.05$).The control group showed the highest TVB-N value on all days. At 90th day, it was found that group G had significantly ($P<0.05$) lowest TVB-N value (28.40) followed by F (31.76), C (42.94), E (43.52), D (47.91), B (51.91) and control group (56.70). It was noticed that the TVB-N value of the marinated herring fillet decreased with increasing HPP level on all days. The results obtained revealed that the quality of the marinated herring fillet treated with HPP used in the research was effective during storage time. Bindu et al., 2013 worked on *F. indicus*.

He observed that Pressure has a significant effect on TVB-N values during storage. It was observed that TVB-N values were decreased with increasing pressure level and lowest value was observed on last day of experiment at highest level of pressure which was 600 MPa (Bindu et al., 2013). In the present study we also have the same observation that group G with highest pressure level has lowest TVB-N value as compared to other groups.

Trimethylamine (TMA-N)

Trimethylamine (TMA-N) is produced in spoiled fish with typical fishy smell and bitter taste. This process occurs due to some specific spoilage bacteria which have the ability to produce high quantity of spoilage causing compounds known as trimethylamine. Trimethylamine is also produced from non-protein nitrogen composite found in seafood known as trimethylamine oxide (TMAO). Trimethylamine oxide transformed into trimethylamine through bacterial action and endogenous enzymatic action (Regenstein et al., 1982). High pressure processing decreased trimethylamine through restricting protein breakdown (Hernández-Andrés et al., 2005). TMA-N value in herring fillets was observed at 0, 15, 30, 45, 60, 75 and 90 days after storage at 4°C (Table 1). At 0 day, TMA-N value of herring fillets of control group sample was (2.51 mg/100 g) and increased in all samples during the storage and at the end of storage on 90th day. TMA-N value was found highest (13.24 mg/100 g) in control group ($P<0.05$). The control group showed the highest TMA-N value on all days. At 90th day, it was found that group G had the significantly ($P<0.05$) lowest herring fillets TMA-N value (4.25) followed by D (5.13), F (5.29), E (5.62), C (6.51), B (6.85) and control group (13.24). It was noticed that the TMA-N value of the marinated herring fillet decreased with increasing HPP level on all days. The results obtained revealed that the quality of the marinated herring fillet treated with HPP used in the research was effective during storage time. It was observed in one study that TMA-N quantity reduced in horse mackerel after HPP treatment at 330 MPa, for 10 minutes at 7°C and at 220 MPa, 250 MPa, 330 MPa, for 10 minutes at 25°C was lower than the control value (Erkan et al., 2011).

HPP treatment higher than 300 MPa gives seafood a very nimble cooked form (Hoover et al., 1989). TMA-N values reduced by stopping the protein breakdown through HPP treatment (Hernández-Andrés et al., 2005). It was also observed in another study of prawn that value of TM-Ne increased in storage samples including control group (Basavakumar et al., 1998). It was observed that different HPP levels gave significantly different values of TMA-N during different days of storage ($P<0.05$) and these values were decrease as pressure was increased as in our study we observed that group G has highest pressure level and lowest TMA-N value.

CONCLUSION

It is concluded from this article that due to perishable nature of fish, it needs proper treatment for long term preservation. There were many traditional thermal processing treatments, but they can change the taste and color of fish product. Therefore some advanced non thermal processing treatments should be applied to fish product preservation with minor change in taste, texture and color of final fish product, which is also a consumer requirement these days. From this study it can be concluded that high pressure processing treatment with combination of marination is an excellent approach to get good quality and taste of herring.

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Table 1. Changes in the physico-chemical properties of marinated herring fillets treated with HPP during storage at 4±1°C

	storage (days)	Control (A)	100MPA/5min (B)	100MPA/10min (C)	300MPA/5min (D)	300MPA/10min (E)	500MPA/5min (F)	500MPA/10min (G)
pH	0	4.40±0.02^{Ag}	4.38±0.01^{Bg}	4.36±0.01^{Cg}	4.35±0.01^{Cf}	4.32±0.01^{Df}	4.29±0.01^{Eg}	4.26±0.01^{Fe}
	15	4.43±0.01^{Af}	4.40±0.01^{Bf}	4.38±0.01^{Cf}	4.36±0.01^{Df}	4.33±0.01^{Ef}	4.31±0.01^{Ff}	4.27±0.01^{Ge}
	30	4.47±0.01^{Ae}	4.43±0.01^{Be}	4.40±0.01^{Ce}	4.39±0.01^{Ce}	4.35±0.01^{De}	4.33±0.01^{Ee}	4.29±0.01^{Fd}
	45	4.51±0.02^{Ad}	4.46±0.01^{Bd}	4.43±0.01^{Cd}	4.42±0.02^{Cd}	4.38±0.01^{Dd}	4.35±0.01^{Ed}	4.31±0.01^{Fc}
	60	4.55±0.01^{Ac}	4.50±0.01^{Bc}	4.47±0.01^{Cc}	4.44±0.01^{Dc}	4.41±0.01^{Ec}	4.38±0.01^{Fc}	4.34±0.01^{Gb}
	75	4.58±0.01^{Ab}	4.54±0.01^{Bb}	4.50±0.01^{Cb}	4.49±0.01^{Cb}	4.45±0.01^{Db}	4.40±0.01^{Eb}	4.34±0.01^{Fb}
	90	4.62±0.01^{Aa}	4.57±0.01^{Ba}	4.53±0.02^{Ca}	4.53±0.02^{Ca}	4.47±0.02^{Da}	4.43±0.03^{Ea}	4.37±0.01^{Fa}
TMA-N (mg/100g)	0	2.51±1.59^{Ac}	2.37±2.07^{Ac}	1.93±1.73^{Aa}	1.74±1.59^{Ac}	1.72±1.78^{Ac}	1.51±1.45^{Ac}	1.27±1.14^{Ac}
	15	2.94±1.23^{Ac}	2.76±0.98^{Abc}	2.50±1.90^{Aa}	2.03±1.49^{Ac}	1.69±1.03^{Ac}	1.73±1.35^{Abc}	1.54±1.93^{Abc}
	30	4.56±2.94^{Abc}	3.73±2.86^{Aabc}	3.60±2.61^{Aa}	3.29±2.08^{Abc}	3.42±2.43^{Abc}	3.36±2.37^{Aabc}	3.19±2.10^{Aabc}
	45	8.90±5.24^{Aab}	5.37±6.42^{ABabc}	5.09±6.75^{ABa}	4.13±1.32^{Bab}	3.85±1.98^{Bab}	3.80±1.77^{Babc}	3.45±1.06^{Babc}
	60	10.69±5.84^{Aa}	6.07±1.45^{Bab}	6.86±7.93^{Aa}	3.58±2.94^{Bbc}	3.91±2.39^{Bab}	3.95±2.89^{Babc}	3.42±1.82^{Babc}
	75	12.78±8.22^{Aa}	6.60±2.33^{Ba}	5.99±2.27^{Ba}	5.61±0.99^{Ba}	5.33±0.92^{Ba}	4.04±2.94^{Bab}	3.70±3.49^{Bab}
	90	13.24±5.77^{Aa}	6.85±1.96^{Ba}	6.51±2.48^{Ba}	5.13±0.84^{Bab}	5.62±0.19^{Ba}	5.29±1.97^{Ba}	4.25±2.44^{Ba}
TVB-N (mg N/100 g)	0	17.60±0.03^{Ad}	15.85±0.03^{Ad}	16.09±0.03^{Ad}	16.17±0.03^{Ad}	16.32±0.02^{Ac}	15.33±0.03^{Ae}	16.05±0.03^{Ac}
	15	25.08±0.03^{Acd}	19.90±0.02^{Bd}	18.56±0.02^{Bd}	19.42±0.02^{Bd}	18.82±0.03^{Bc}	17.17±0.03^{Bde}	16.30±0.02^{Bc}
	30	33.64±0.03^{Abc}	27.93±0.03^{ABcd}	25.53±0.02^{ABCcd}	26.08±0.03^{ABCcd}	24.48±0.04^{ABCbc}	21.79±0.03^{BCcd}	17.67±0.03^{Cc}
	45	39.81±0.03^{Ab}	37.66±0.02^{ABac}	33.74±0.03^{ABbc}	34.24±0.02^{ABbc}	35.06±0.02^{ABab}	24.65±0.02^{BCbc}	20.75±0.02^{Cbc}
	60	44.31±0.02^{Ab}	40.89±0.02^{Aab}	38.34±0.03^{ABab}	37.57±0.01^{ABab}	34.00±0.03^{ABCa}	26.94±0.03^{BCab}	24.39±0.03^{Cab}
	75	58.37±0.03^{Aa}	48.56±0.01^{ABab}	45.66±0.02^{Bab}	41.77±0.02^{Bab}	38.05±0.03^{BCa}	28.52±0.02^{Cab}	27.32±0.02^{Ca}
	90	56.70±0.04^{Aa}	51.91±0.02^{ABa}	42.94±0.03^{BCa}	47.91±0.03^{ABa}	43.52±0.01^{BCa}	31.76±0.03^{CDa}	28.40±0.02^{Da}

Means indicated by different capital letters in the same row differ significantly (p<0.05). Means indicated by different lowercase letters in the same column differ significantly (p<0.05).