The Some Physicochemical, Microbiological and Sensory Properties of Butters Treated by Different Plant Hydrosol

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Abstract

This study evaluated the physicochemical and microbiological properties of butter subjected to different hydrosols treatment were evaluated. For this purpose, butters were washed with 3 different types of hydrosols (rosemary, black cumin, thyme), vacuum packed and stored at 4°C for 30 days. At 0th, 10th, 20th and 30th days, microbiological, peroxide, free fatty acidity, sensory analysis and color measurements were carried out. Peroxide values were undetectable for the butter samples, but the free fatty acidity values were reached 1.76-2.14 KOH / gram butter at the end of the 30th day. Sensory analysis revealed that control samples were more appreciated by the panelists. The total mesophilic aerobic bacteria (TMAB) number of hydrosol washed samples were < 2 log cfu/g and for the control sample it was found to be 3.15 log cfu/g at the end of the 30th day when microbiological analysis was investigated. At the end of storage, the highest yeast-mold number was found in the control sample (6.26 log cfu/g), and the lowest one was in the black cumin hydrosol washed sample. In conclusion, it was observed that hydrosol washed samples were not preferred from a sensorial point of view whereas color parameters did not change and microorganism levels were decreased.

Keywords: Butter, Hydrosol, Antimicrobial, Antioxidant.

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1. Introduction

Butter is an animal foodstuff obtained by churning the milk of animals such as sheep and cows. The raw material of butter is milk fat. Butter is composed of 84% fat, 0.8% protein, 0.5% carbohydrate, 0.2% ash and 15-16% water. It is particularly rich in vitamins A and D. It serves as an indispensable and challenging-to-replace raw material for the food industry and the food and beverage sector (MEGEP, 2013). It is an ingredient that enhances all kinds of dishes from roast meat to special sauces and gives a distinct flavor to the dishes. Butter is an indispensable food product that we spread on bread at breakfast, add to bakery products, and that imparts a distinct aroma to our meals.

Efforts to transform milk fat into a more durable product and offer it for consumption as butter date back to ancient times. Although there are records of butter in 3000 BC in Western sources, it was also found in the records of the Urartu, who lived in Eastern Anatolia in 8000 BC. Butter production started to be established towards the middle of the 19th century relying on the principle of creaming milk in containers. The first churns were made using wooden materials. However, instead of these materials, new methods and technologies started to be used in production as a result of the rapid progress of technological development, superseding traditional ways of production and enabling faster and standardized production has been possible. The production of quality and standard butter in enterprises producing milk and dairy products is crucial to protect consumer health and to produce products in accordance with legal regulations and standards (Oğuz, 1976).

A major problem in our country is that butter is not a sufficiently durable food product. Most of the time, butter cannot be stored for more than a few weeks and many sensory defects occur during storage. Attempts are made to increase its durability by converting it into clarified butter by salting or melting. This practice makes it difficult to use butter as a breakfast product. Oxidation of the fat in butter is one of the main causes of food spoilage and can cause significant economic losses for the food industry. This is because oxidation causes the formation of various off-flavors in edible fats

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and oils and other fat-containing foods, called rancid flavors, which render foods unacceptable or reduce their shelf life. Furthermore, oxidative reactions are reported to reduce the nutritional value of foods and some oxidation products have toxic effects (Öztürk, 2002).

Hydrosols are also referred to as essential oil or organic hydrosol. Essential oils are volatile, strongly odorous and oily mixtures obtained from plants or plant juices by water or water vapor distillation, which are liquid at room temperature, but sometimes freeze. Hydrosols and essential oils are distillate extracts obtained from organic plants by supercritical fluid extraction or pressing. Hydrosols have many medicinal benefits because they contain the water-soluble constituents, vitamins and minerals of the distilled plant. Hydrosols may also contain small amounts of aromatic oils of the treated plant (Çalıkoğlu et al., 2006; Sagdic et al., 2013).

The most important advantages of hydrosols for the food industry are that they can be obtained easily and with low cost methods and they do not cause health problems in humans (Tornuk et al., 2011). Various edible plants and spices are added to perishable foods such as meat and fish in order to prolong the preservation period as well as to add flavor to foods. In addition, their use in the treatment of diseases has a history dating back to ancient times (Sağdıç et al., 2003). It is known that many plants growing in the vegetation of the Mediterranean region are rich in aroma and essential oils. The heterogeneous distribution of the region in terms of soil and climate naturally allows for aromatic plant diversity (Sağdıç et al., 2005). Many plants rich in essential oils such as thyme, sage, mint, rosemary are widely grown in our country. The activities of these plants against microorganisms that cause food spoilage or pathogenic microorganisms have been investigated in laboratory environments (Sağdıç et al., 2005). Hydrosols of thyme (Thymbra spicata L.), sage (Salvia pilifera Montbret Aucherex Bentham), tea (Stachys pumilia Banks&Sol.), coral mole (Origanum majorana L.) and mint (Micromeria fruticosa L. fruticosa L.) showed inhibitory effects against pathogens such as Escherichia coli O157:H7, Staphylococcus aureus, Yersinia enterocolitica and Listeria monocytogenes (Sagdic et al., 2013; Tornuk et al., 2011; Sağdıç et al., 2002; Özkan et al., 2003; Sağdıç, 2005).

In this study, the effect of hydrosol obtained from 3 different materials, which are used in foods for flavoring and consumed as tea in our country, on the microbial, oxidative, and sensory properties of butter was investigated. This was to examine the potential for using hydrosol, both separately and in combination (as a mixture), in butter production.

2. Material and Methods

2.1. Material

In this study, butter was produced by churning technique in the Food Pilot Application Center of Safiye Çıkrıkçıoğlu Vocational School. These butters were washed with rosemary, black cumin, thyme and mixed hydrosols prepared in advance at the last washing stage for 5 minutes and a control group was formed. The butters were vacuum packed under aseptic conditions, 250 grams each, delivered to the laboratory under appropriate conditions and kept at 4°C until the analysis was performed. Butter samples were analyzed on days 0, 10, 20 and 30.

2.2. Method

Peroxide, free acidity, microbiological, color and sensory analysis of butter samples were carried out.

2.2.1. Peroxide Analysis

Peroxide determination involved dissolving the prepared samples in 10 ml of chloroform solution, adding 15 ml acetic acid solution and 1 ml saturated potassium iodide solution, shaking for 1 minute, and then dark-incubating for 5 minutes. Following the addition of 75 ml of distilled water and 1 ml of starch solution, the sample was titrated with sodium thiosulfate. The presence of peroxide was determined by observing for a color change during titration (Karaman et al., 2012). The peroxide value (PV) was then calculated according to the equation: $PV= [(V1-V0) N]/M$. Here, where V1 is the amount of sodium thiosulfate used for titration (mL), V0 is the amount of sodium thiosulfate used for the blank (mL), N is the normality of sodium thiosulfate and M is the weight of sample (g). PV was expressed as milliequivalents (meq) of active oxygen per kg of butter.

2.2.2. Free Fatty Acid Analysis

Three parallel samples of 2 grams of butter samples were placed in Erlenmeyer flasks and dissolved in 10 ml of ethanol: diethylether solution. The solution was then titrated with Potassium Hydroxide Solution (KOH 0.5 N) in the presence of phenolphthalein (Simsek, 2011). The free fatty acid number was then calculated according to the equation: $FFA, \% = (V/m) \times 5.6$mg KOH/gram butter. Here, where FFA is the acid number, V is the consumption volume, m is sample weight (g).

2.2.3. Microbiological Analysis

The sterile packaged samples brought to the laboratory were homogenized by weighing 10 g into sterile ringer solution prepared in advance for microbiological analysis under sterile conditions. Then, serial dilutions were prepared and cultured on specific media. Results were expressed as log cfu/g.

Plate Count Agar (PCA) was used to count TMAB in butter samples. The previously prepared PCA medium was inoculated by spreading method and incubated at 30°C for 2-3 days. Colonies were counted at the end of incubation (Sagdic et al., 2012).

Dichloran Rose Bengal Chloramphenicol (DRBC) agar was used for total yeast-mold count in butter samples. Appropriate dilutions were inoculated onto DRBC agar medium by spreading method and petri dishes were incubated at 25°C for 3-5 days. At the end of incubation, colonies were counted (Sagdic et al., 2010).

De Man, Rogosa and Sharpe (MRS) agar was used for Lactic Acid Bacteria (LAB) enumeration in butter samples. Appropriate dilutions were spread on MRS agar medium and petri dishes were incubated at 30°C under anaerobic conditions for 24-48 hours. At the end of incubation, colonies with cream to white color were counted (Sagdic et al., 2012).

2.2.4. Color Analysis

L*, a* and b* values were analyzed using Konica Minolta (Japan) color spectrophotometer in our laboratory. Color analysis was performed for each sample in 5 parallels.

2.2.5. Sensory Analysis

In order to determine the sensory characteristics of the butter samples, 5 people were selected in accordance with the panelist rules. The samples were asked to be evaluated in terms of flavor, odor and general taste. The panelists were prevented from influencing each other and the butter samples were tasted at certain intervals. The panelists were asked to rate their responses on a scale from 1 to 9 (9: very good, 1: very bad). The standard deviation and mean of the data were taken and evaluated (Yetim & Kesmen, 2012).

3. Results and Discussion

3.1. Oxidative Properties of Butter

The peroxide value, a key parameter, informs about the degree of oxidation of oils. Peroxides contribute to the formation of a bitter taste and an unpleasant odor in fat-rich foods, serving as a significant criterion for the food industry. Peroxides were undetected in the peroxide number analysis of butters treated with hydrosols on days 0, 10, 20, and 30 (Table 1). This result bears significance, suggesting that the use of hydrosol does not augment the peroxide value.

Free fatty acidity, an essential quality index for oil, serves routinely as a shelf-life monitoring parameter. It ranks among the most important analyses in quality control since an increase in free fatty acidity or its abundance signifies reduced stability against oxidation. This is an important indicator that the oil will begin to turn bitter. Free fatty acidity values of butter samples are depicted in Table 1. As per the table, it was ascertained that the free fatty acidity values of the butter samples on day 0 spanned between 1.37-2.24 KOH/gram butter. The free fatty acidity values of the butter samples washed with thyme and black cumin hydrosols were lower than those of the other samples, with these values determined as 1.37 and 1.94 KOH/gram butter, respectively. The free fatty acidity values of the butter samples exhibited no significant fluctuation on the 10th and 20th day of storage. On the 30th day of analysis, the free fatty acidity values of the butter samples ranged between 1.76-2.14 KOH/gram butter. The free fatty acidity values of the butter samples washed with rosemary and black cumin hydrosols were lower than those of the other samples, with these values recorded as 1.76-1.91 KOH/gram butter, respectively.

The butter sample treated with rosemary hydrosol revealed a decrease in the free fatty acidity value on the 30th day compared to other day analysis (Table 1). In the butter sample treated with thyme hydrosol, the free fatty acidity value on day 0 was lower than the other day analysis.

Table 1. Peroxide and FFA values of butters produced by using different plant hydrosols

Sample	0th	10th	20th	30th
	Free Fatty Acidity (KOH/gram butter)			
Control	2.24±0.00	2.42±0.07	2.37±0.14	2.03±0.42
Rosemary	2.24±0.00	2.13±0.15	2.16±0.06	1.76±0.33
Black cumin	1.94±0.00	2.18±0.26	2.22±0.02	1.91±0.01
Thyme	1.37±0.00	2.21±0.03	2.28±0.57	2.01±0.13
Mixed	2.22±0.00	2.03±0.14	2.22±0.27	2.14±0.16
	Peroxide (meq g O_2/kg butter)			
Control	ND	ND	ND	ND
Rosemary	ND	ND	ND	ND
Black cumin	ND	ND	ND	ND
Thyme	ND	ND	ND	ND
Mixed	ND	ND	ND	ND

3.2. Microbiological Properties of Butter

Table 2 contains Total Mesophilic Aerobic Bacteria (TMAB), yeast-mold, and Lactic Acid Bacteria (LAB) counts in butter samples. While the 0, 10, 20 day analysis values remained unchanged in the control group butter sample, these values dwindled to 3.15 log cfu/g in the 30th day analysis. In the butter samples washed with other plant hydrosols, the 0, 10, 20 day analysis values remained unchanged, whereas these values receded to <2 log cfu/g on the 30th day analysis.

The yeast-mold counts of the butter samples washed with herb hydrosols on day 0 were the lowest compared to other days, recorded as <2 log cfu/g (Table 2). Butter samples washed with black cumin hydrosol demonstrated lower yeast-mold counts,

recorded as <2, 3.34, and 3.95 log cfu/g on days 0, 10, and 30, respectively (Table 2).

The LAB count analysis on day 10 in the butter samples washed with thyme hydrosol was lower than in butter samples washed with other hydrosols, with this value registered as 2.95 log cfu/g (Table 2).

Table 2. Microorganism counts of butters produced by using different plant hydrosols (log cfu/g)

Sample	Storage (Days)			
	0th	10th	20th	30th
	TMAB			
Control	5.99±0.03	6.19±0.06	5.39±0.10	3.15±0.21
Rosemary	5.95±0.01	6.10±0.02	5.39±0.06	<2
Black cumin	5.33±0.01	6.19±0.02	5.66±0.05	<2
Thyme	5.57±0.02	6.13±0.02	5.72±0.05	<2
Mix	5.86±0.02	6.15±0.04	5.80±0.04	<2
	Yeast and Mold			
Control	2.24±0.34	4.89±0.04	5.31±0.11	6.26±0.02
Rosemary	2.24±0.34	4.62±0.04	4.96±0.08	6.24±0.00
Black cumin	<2	3.34±0.06	5.13±0.03	3.95±0.07
Thyme	<2	4.83±0.03	5.70±0.04	6.19±0.02
Mix	2.30±0.43	4.48±0.01	5.62±0.01	5.84±0.06
	LAB			
Control	4.83±0.04	4.15±0.27	4.97±0.05	3.87±0.12
Rosemary	4.73±0.13	3.94±0.14	5.04±0.06	3.39±0.12
Black cumin	4.38±0.05	3.63±0.11	4.64±0.29	3.15±0.21
Thyme	4.24±0.05	2.95±0.07	5.04±0.05	3.54±0.09
Mix	4.75±0.12	4.04±0.06	4.82±0.02	3.45±0.21

3.3. Sensory Properties of Butter

During the sensory analysis on the 0th, 10 th, 20 th, and 30 th day, the control group butter earned the highest score concerning flavor, odor, and overall liking. Butter washed with rosemary and mixed hydrosols scored the lowest within these values. Related values are displayed in Table 3.

Table 3. Sensory properties of butters produced by using different plant hydrosols

Sensory Properties	Control	Thyme	Black cumin	Rosemary	Mix
	0th day				
Flavor	8.40 ±0.55	6.20 ±2.49	6.10 ±2.25	5.46 ±1.93	6.10 ±2.66
Odor	8.60 ±0.55	6.00 ±2.12	6.60 ±1.52	5.80 ±2.86	6.40 ±2.51
Overall acceptability	8.56 ±0.52	7.16 ±2.35	6.72 ±2.33	6.30 ±2.31	6.74 ±2.75
	10th day				
Flavor	8.60 ±0.55	7.40 ±1.52	7.20 ±2.68	6.00 ±1.22	6.70 ±1.64
Odor	9.00 ±0.20	7.40 ±2.51	7.60 ±1.52	6.40 ±2.07	7.30 ±0.97
Overall acceptability	8.70 ±0.45	7.57 ±2.03	7.60 ±2.19	6.32 ±1.23	7.02 ±1.47
	20th day				
Flavor	8.80 ±0.45	7.70 ±0.45	7.60 ±1.34	6.60 ±1.52	7.10 ±0.74
Odor	8.80 ±0.45	7.90 ±0.74	7.20 ±0.84	6.60 ±1.52	6.70 ±1.20
Overall acceptability	8.80 ±0.45	8.00 ±0.79	7.80 ±0.84	7.10 ±1.82	7.30 ±0.84
	30th day				
Flavor	8.20 ±1.10	6.00 ±1.73	7.20 ±0.84	5.00 ±2.45	5.00 ±1.87
Odor	8.20 ±1.10	6.20 ±1.92	5.40 ±2.19	7.40 ±1.14	5.75 ±0.96
Overall acceptability	8.60 ±0.55	7.00 ±0.71	7.40 ±0.55	7.40 ±0.55	6.40 ±1.14

Color analysis of butter also formed part of this study. Color, flavor, and texture constitute three crucial characteristics for a food's acceptability. However, the initial judgment about food quality is usually predicated on the product's color. In this context, manufacturers must pay careful heed to the color properties of the product and color shifts during processing. Thus, color measurements serve as an index in analyzing quality alterations due to factors like food processing, storage, etc., in ascertaining the compliance of food quality to standards, and in the quality control of raw and processed foods (Karaman et al., 2012). The outcomes of the 0th, 10th, 20th, and 30th day color analysis of the control group butter and butter washed with plant hydrosols are provided in Table 4 as L, a, b values. The a* values ranged between

Table 4. Color properties of butters produced by using different plant hydrosols

	L*	a*	b*
		0th day	
Control	90.37±0.22	1.33±0.04	15.88±0.12
Rosemary	90.01±0.01	1.17±0.01	14.81±0.01
Black cumin	90.21±0.01	1.21±0.01	15.29±0.02
Thyme	89.39±0.06	1.10±0.01	14.98±0.01
Mix	89.43±0.05	1.21±0.01	15.03±0.02
		10th day	
Control	88.56±0.18	1.00±0.02	15.31±0.05
Rosemary	89.26±0.02	0.93±0.01	15.42±0.02
Black cumin	89.42±0.04	0.90±0.04	15.26±0.05
Thyme	89.31±0.02	1.02±0.01	15.88±0.03
Mix	89.64±0.00	1.10±0.01	15.74±0.01
		20th day	
Control	89.74±0.05	1.41±0.01	16.04±0.05
Rosemary	89.78±0.01	1.29±0.01	15.79±0.01
Black cumin	89.70±0.02	1.32±0.01	16.01±0.02
Thyme	90.02±0.06	1.17±0.01	15.37±0.03
Mix	89.82±0.04	0.99±0.01	14.39±0.03
		30th day	
Control	89.33±0.25	1.17±0.02	15.59±0.07
Rosemary	89.04±0.03	1.13±0.02	15.13±0.03
Black cumin	89.05±0.03	1.37±0.02	15.64±0.07
Thyme	87.92±0.14	1.23±0.05	15.32±0.07
Mix	89.04±0.08	1.21±0.04	15.47±0.08

0.90 and 1.10 in the 10th day analysis. A marked decrease was observed in the a* values of the butter samples washed with rosemary and black cumin hydrosols compared to other day analyses during the 10th day analysis. These values stood at 0.93±0.01 for rosemary and 0.90±0.04 for black cumin.

In the 20th day analysis, a significant dip was recorded in the a* and b* values of the butter sample washed with mixed hydrosol compared to other day analyses. The a* and b* values were recorded as 0.99±0.01 and 14.39±0.03, respectively. The L* values of butter washed with thyme hydrosol ranged between 90.02±0.06 and 87.92±0.14. The 30th day analysis documented a significant reduction in the L* value of the butter sample washed with thyme hydrosol compared to other day analyses. This value stood at 87.92±0.14.

Conclusion

The extension of the shelf life of butter is of high significance, and positive changes have been observed in both the microbiological and oxidative properties of all butters produced with hydrosols. Furthermore, it was established that the usage of hydrosols did not lead to significant alterations in the butter samples. Although the sensory quality of the butter samples using hydrosols remained within acceptable levels, it has notably declined compared to the control samples. The change in sensory properties could become more negative depending on the specific material from which the hydrosol was derived. This implies that despite the significant benefits of hydrosols on the shelf life of butter, they exhibited a negative impact on the sensory properties of the butter. Based on these substantial findings, it is suggested that further research be conducted on the usage of hydrosols derived from different materials that could potentially complement the sensory properties of butter.

Declaration of Competing Interest

The authors declare that they have no financial or non-financial competing interests.

Author's Contributions

O. Özdoğan, L.M. Renkli, A.C. Taflı: *Definition, Data Collection, Investigation Conceptualization, Methodology, Editing*.

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