applied sciences

MDPI

Article

Food Products with High Antioxidant and Antimicrobial Activities and Their Sensory Appreciation

Mihaela Adriana Tița [1,*], Maria Adelina Constantinescu [1], Ovidiu Tița [1], Endre Mathe [2], Loreta Tamošaitienė [3] and Vijolė Bradauskienė [3,4]

[1] Department of Agricultural Sciences and Food Engineering, Lucian Blaga University of Sibiu, Doctor Ion Rațiu No. 7, 550012 Sibiu, Romania; adelina.constantinescu@ulbsibiu.ro (M.A.C.); ovidiu.tita@ulbsibiu.ro (O.T.)
[2] Institute of Nutrition, Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen, Böszörményi út No. 138, 4032 Debrecen, Hungary; endre.mathe64@gmail.com
[3] Department of Food Technology and Nutrition, Klaipeda State University of Applied Sciences, Bijūnų g. No. 10, 91223 Klaipeda, Lithuania; loreta.tamo14@gmail.com (L.T.); v.bradauskiene@kvk.lt (V.B.)
[4] Food Institute, Kaunas University of Technology, Radvilenu Road No. 19C-413, 44239 Kaunas, Lithuania
* Correspondence: mihaela.tita@ulbsibiu.ro; Tel.: +40-751-057-321

Abstract: (1) Background: The demand for healthy and nutritious food is growing worldwide. Fermented dairy products are highly valued by consumers for their health benefits. Kefir is a fermented dairy product that brings many benefits to the consumer due to its antioxidant, anticancer, antidiabetic, antihypertensive and antimicrobial properties. Extracts from various plants in the form of volatile oils have a beneficial efct on consumer health. Following the research, their antioxidant and antimicrobial activities were demonstrated. (2) Methods: In the present study, the main purpose was to obtain a fermented dairy product with a high nutritional value; therefore, kefir, enriched with three types of volatile oils, namely, volatile mint oil, volatile fennel oil and volatile lavender oil, was made. The kefir samples obtained were sensory and texturally analyzed. The beneficial effect on health must also be studied in terms of the acceptability of these products by consumers from a sensory point of view. A non-numerical method based on several multi-personal approval criteria was used to interpret the results obtained in the sensory analysis. In the textural analysis, the consistency, cohesiveness and firmness of the kefir samples were analyzed. (3) Results: The samples enriched with volatile oils obtained superior results compared to the control sample in both conducted examinations. Kefir samples with volatile oils retained their sensory and textural characteristics for a longer time during storage. (4) Conclusions: The volatile oils added to kefir positively influenced the sensory and textural characteristics of the finished product.

Keywords: kefir; volatile oils; sensory analysis; textural analysis; bioactive compounds

check for updates

Citation: Tița, M.A.; Constantinescu, M.A.; Tița, O.; Mathe, E.; Tamošaitienė, L.; Bradauskienė, V. Food Products with High Antioxidant and Antimicrobial Activities and Their Sensory Appreciation. *Appl. Sci.* **2022**, *12*, 790. https://doi.org/10.3390/app12020790

Academic Editors: Codină Georgiana Gabriela, Adriana Dabija and Lăcrămioara Rusu

Received: 9 December 2021
Accepted: 7 January 2022
Published: 13 January 2022

1. Introduction

Fermented dairy products are highly valued by consumers for their health benefits. They can be consumed from an early age [1]. The nutritional characteristics of fermented dairy products are determined by the nutrients present in the milk, those from other ingredients and those resulting as metabolites generated by the fermentation of lactic acid bacteria. Lactic fermentation causes changes in the composition, consisting of the production of lactic acid from lactose and the formation of peptides and amino acids from proteins and fatty acids from lipids [2].

The demand for healthy and nutritious foods is growing worldwide. It is desirable to make food products that, in addition to satisfying the need for food, also bring numerous nutritional contributions to the health of the consumer [3]. Due to the intensification of food production, many changes take place in terms of the quality and safety of these products [4]. Creating products capable of meeting food and health needs is of great interest due to the increase in economic competitiveness [5]. Food processors must produce foods that prevent consumers from becoming sick and help to improve their physical and mental health [3].

A major stress factor for people is the current situation caused by the COVID-19 pandemic, as well as the strict but necessary measures that have been taken to prevent the spread of the virus. Doctors recommend adopting a healthy lifestyle so that the transition is easier over this period and to mitigate the effects caused by the pandemic stress. Without adopting a healthy lifestyle, or avoiding sedentarism as much as possible, people can develop anxiety, depression or cardiovascular and mental diseases [6].

After several studies, it was found that volatile oils make an extraordinary contribution to the health of consumers. These oils are extracted either from the aerial part of the plant or from its root [7]. Volatile oils are increasingly being used in the pharmaceutical and food industries due to their antimicrobial and antioxidant properties. The rising interest in natural substances has led to the growing interest in finding new applications for these substances [8].

The volatile oils extracted from certain plants have antimicrobial action. This action is visible on the pathogenic bacteria *Listeria monocytogenes*, *Listeria innocua* and *Salmonella typhimurium*. Volatile oils also have antioxidant activity. Free radicals cause the oxidation of biomolecules, including proteins, amino acids and DNA, and produce molecular changes related to aging, arteriosclerosis and cancer [9].

Fennel (*Foeniculum vulgare* L.) belongs to the *Umbelliferae* family and is an aromatic plant considered one of the oldest cultivated medicinal plants in the world [10]. In Romania, fennel is grown in the Moldova, Dobrogea, Timiș and Oltenia areas. The most important fennel compounds are trans-anethole (63.30%), pinene (11.11%) and fencone (8.32%) [11]. Fennel volatile oil has antioxidant and antimicrobial capacities [12]. Regarding antimicrobial activity, in 2013, Thompson et al. conducted a study investigating its antimicrobial capacity against *Escherichia coli* bacteria. The results showed that this type of volatile oil has high antimicrobial activity [13]. In 2018, Salma et al. conducted another study using the disc diffusion method, which is also called the Kirby–Bauer method. The result of this method demonstrated high antimicrobial activity [14]. In the study conducted by Pande and Preetha in 2017, the antioxidant activity of fennel essential oil was measured using the DPPH (2,2-diphenylpicryl hydrazyl) method. This study showed that fennel volatile oil has a high antioxidant activity [15].

Lavender (*Lavandula angustifolia*) is part of the *Lamiaceae* family and is an aromatic plant used in folk medicine to relieve stress and anxiety [16]. Lavender volatile oil is a complex blend of mono alcohols and sesquiterpenoids, esters, oxides and ketones [17]. The main components of lavender volatile oil are the monoterpenoids linalool, linalyl acetate, 1,8-cineole, β-ocimen, terpinen-4-ol and camphor [18]. Lavender essential oil is recognized for being used in the treatment of anxiety, migraines, stress, irritability, exhaustion, depression, headaches, digestion, colds, flatulence, insomnia, loss of appetite, upset stomach, liver disease, nervousness and aroma [19]. In 2017, Zhao et al. showed that lavender volatile oil is effective in inhibiting the tumor growth of human carcinogenic xenografts in mice. Linalool mainly contributed to this effect [20]. Regarding antimicrobial activity, in 2015, Kunicka-Styczyńska et al. investigated this against *Staphylococcus aureus*, *Escherichia coli*, *Candida* spp. and *Aspergillus niger*. The result obtained was a positive one; this type of oil showed high antimicrobial activity [21]. In the 2017 study by Andrys et al., the antioxidant activity of volatile lavender oil was investigated. The DPPH method was used according to the procedures described by Kumaran and Karunakaran (2007) and Wojdyło et al. (2007). The reduction in the DPPH radical was determined spectrophotometrically by measuring the absorbance at 517 nm. Finally, it has been shown that volatile lavender oil has a high antioxidant capacity [22].

Mint (*Mentha piperita* L.) is part of the *Lamiaceae* family and is a perennial plant with a characteristic taste and smell [23]. The main components of volatile mint oil are menthol, mentofuran, isomentone, caryophyllene, eucalyptol, linalool, limonene, carvone, pulegone and α-terpinol [24]. Numerous specialized studies have been performed over the years to demonstrate the antimicrobial and antioxidant activities of volatile mint oil. In 2017, Ramos et al. conducted a study demonstrating the antimicrobial and antioxidant activities of volatile mint oil. The antimicrobial activity of this oil was tested against two strains of bacteria: *Staphylococcus aureus* and *Escherichia coli*. The test results indicated high antimicrobial activity against these bacteria. Regarding the antioxidant activity, the 2,2-diphenyl-1-picrylhydrazyl method was used. The reading was performed on a spectrophotometer at an absorbance of 517 nm, and it was shown that volatile mint oil has a high antioxidant activity [25]. In Singh's 2015 study, the antioxidant activity of volatile mint oil was also studied using the DPPH method. The reading was also performed on a spectrophotometer at an absorbance of 517 nm, and the result was identical to that of the previously presented study [26].

Kefir is a dairy product that is obtained from kefir grains that contain a specific combination of bacteria and yeast [27]. It is obtained by adding a culture called "kefir grains" to milk, thus producing a creamy texture, sour taste and low effervescence [28]. The microbial composition of kefir varies depending on the type and composition of the milk, the culture medium, the fermentation period and the temperature, as well as the storage conditions. *Lactobacillus*, *Lactococcus*, *Streptococcus* and *Leuconostoc* are the most common bacteria and *Saccharomyces*, *Kluyveromyces* and *Candida* are the most common yeasts in kefir [27]. Kefir has various health benefits due to its antioxidant, anticancer, antidiabetic, antihypertensive and antimicrobial properties [29].

In the present study, the main objective was to obtain a fermented dairy product with a high nutritional value, and for this purpose, kefir enriched with three types of volatile oils, namely, volatile mint oil, volatile fennel oil and volatile lavender oil, was made. The kefir samples obtained were sensory and texturally analyzed. The beneficial effect on health must also be studied in terms of the acceptability of these products by consumers from a sensory point of view.

2. Materials and Methods

2.1. Extraction of Volatile Oils

Mint and lavender, the dried and crushed aerial parts (grass), and fennel seeds were used to extract and dose the volatile oils. The volatile oil was extracted by entrainment with water vapor using the Neo-Clevenger apparatus modified by Moritz (method according to the Romanian Pharmacopoeia edition X) [30]. The volatile oils obtained had a characteristic odor and were pale yellow to greenish yellow (for mint). The plants were harvested from plantations in Sibiu, Romania.

2.2. Encapsulation of Volatile Oils in Sodium Alginate

Volatile oils extracted from various vegetable products require special storage conditions and are very sensitive to the action of environmental factors. Because of this, it was decided to encapsulate these oils in sodium alginate. Alginate is a natural polysaccharide extracted from brown algae [31]. To make the capsules with volatile oils, three varieties of oils were used: volatile mint oil, volatile fennel oil and volatile lavender oil. From each assortment of volatile oil, 30 µL and over 10 mL of 2% sodium alginate solution were added. The capsules obtained had a characteristic odor of each type of volatile oil used and an opalescent white color. The size of each capsule was about 240 µm, and they had a gelatinous structure.

2.3. Obtaining Samples of Kefir from Cow's Milk with the Addition of Volatile Oils Encapsulated in Sodium Alginate

Raw milk was pasteurized for 25 min at a temperature of 85–90 °C. Cow's milk came from a farm in Sibiu, Vulpăr village. After cooling to 20 °C, pre-mixed powder milk was added with a quantity of warm milk and a starter culture. A mix of LYOFAST cultures, MS 059 DT, manufacturer SACCO, was used. Starter culture composition was *Lactococcus lactis subsp. lactis*, *Lactococcus lactis subsp. cremoris*, *Lactococcus lactis subsp. lactis biovar diacetylactis* and *Leuconostoc*. The amount of powder milk used was 150 g for 2 L of milk, and the amount of starter culture was 0.15 g for the same amount of milk. The seed milk was poured into plastic containers with a capacity of 250 g, and then the capsules with volatile oils were added. Then, 1 g of the capsules was added to 100 g of the kefir sample. The thermostat was set in two stages; thermostat 1 was set at 18 °C for 10 h, and thermostat 2 was set at 10 °C for 8 h. The plastic containers with kefir samples were stored in a refrigerator at a temperature of 4 °C and covered with cling film. In the end, four types of kefir were obtained: cow's milk kefir with the addition of encapsulated volatile mint oil, cow's milk kefir with the addition of encapsulated lavender volatile oil, cow's milk kefir with the addition of volatile fennel oil encapsulated and a control sample (cow's milk kefir in which no volatile oil was added).

2.4. Sensory Analysis

The tasting was carried out by a team of seven amateur tasters who regularly consume kefir, and the selected periods were the first day, on the 10th day and on the 20th day of storage. To perform the sensory analysis, a non-numerical method was used based on several multi-person approval criteria described by Fadhil and collaborators in 2017 and 2020 [32].

The assessed characteristics of each kefir assortment were consistency, color, viscosity, taste and odor. Table 1 shows the evaluation scale used to gather the tasters' opinions, and Table 2 shows the level of importance of the criteria based on the scale.

Table 1. Linguistic assessment scale [32].

Scale	Description	Abbreviation
1	Like very much	LV
2	Like moderately	LM
3	Like slightly	LS
4	Neither like nor dislike	NT
5	Dislike slightly	DS
6	Dislike moderately	DM
7	Dislike very much	DV

Table 2. Criteria importance level [32].

Scale	Description	Abbreviation
1	Very high	LV
2	High	LM
3	Neither like nor dislike	NT
4	Low	DM
5	Very low	DV

After establishing the evaluation scale and the level of importance of the criteria, a matrix of evaluation criteria was formulated based on the opinion of the evaluators and the chosen alternatives. By using Formula (1), the denial importance level of criteria was determined.

$$\text{Neg}\ (W_k) = (W_{q-k+1}) \tag{1}$$

where:
Neg (W_k) = negation of criteria k;
k = index;
q = scale amount.

For the approval process based on criteria, Formula (2) was used.

$$V_{ij} = \min\ [\text{Neg}\ (W_{ak}) \vee V_{ij}\ (a_k)] \tag{2}$$

where:
V_{ij} = alternative i by person j;
V_{ij} (a_k) = alternative i by person j on criteria k;
k = 1, 2, . . . , m.

Formula (3) was used to determine the value weights.

$$Q_k = \text{Int}\,[1 + (k \cdot (q - 1)/r)] \tag{3}$$

where:
Q_k = score k;
Int = integer;
R = number of assessors.

Formula (4) was used to determine the tasting process of the tasters.

$$Vi = f(Vi)\ \max\,[Qj \wedge bj] \tag{4}$$

where:
Vi = total score for alternative i;
Qj = score j;
j = 1, 2, . . . , m;
bj = order from the biggest alternative score i from alternative score j [32].

2.5. Texture Profile Analysis

The analysis of the texture profile of the kefir samples was performed at room temperature (25 °C) using the texture analyzer TA.XT*puls*C equipped with specialized software for texture analysis. The calibration of the force was performed with the help of a weight of 160 g [33]. A disc extruder was used to extrude the product up and around the edge of the disc. The effort to do this was measured, and the results indicate viscosity [34]. Firmness is defined as the peak force obtained during the first compression cycle. Cohesion is defined as the working area of the negative force, representing the work required to remove the compression probe. Consistency is defined as the energy required to chew solid food [33].

3. Results

3.1. Sensory Analysis

3.1.1. Determining Alternatives

In the initial stage, the calculation of the negation of the importance level of the criteria was performed using Formula (1), so the negation of the value of the criteria weight was obtained based on each index k. The results of the calculation of the negation of the criteria are presented in Table 3.

Table 3. Negation of criteria importance level [32].

Criteria Importance Level	The Negation of Criteria Importance Level
Criteria 1 = Very high	Criteria 1 = Very low
Criteria 2 = High	Criteria 2 = Low
Criteria 3 = Neither like nor dislike	Criteria 3 = Neither like nor dislike
Criteria 4 = Low	Criteria 4 = High
Criteria 5 = Very low	Criteria 5 = Very high

The opinions of the tasters obtained from the distribution of the questionnaire are presented in Table 4.

Table 4. Criteria of assessment by each person of all alternatives.

Person	Alternative	Criteria														
		Consistency			Viscosity			Color			Taste			Smell		
		Day 1	Day 10	Day 20	Day 1	Day 10	Day 20	Day 1	Day 10	Day 20	Day 1	Day 10	Day 20	Day 1	Day 10	Day 20
D1	A1	LM	LV	LM	LS	LV	LM	LM	LV	LM	LS	LM	LM	LM	LV	LM
	A2	LS	LM	LM	LS	LM	LS	LM	LM	LS	LM	LV	LM	LM	LV	LM
	A3	LM	LM	LM	LM	LM	LM	LM	LV	LM	LM	LV	LM	LM	LV	LM
	A4	LM	LM	LS	LS	LM	NT	LM	LM	NT	LS	LS	NT	LS	LS	NT
D2	A1	LM	LV	LM	LM	LV	LM	LV	LV	LM	LM	LV	LM	LM	LV	LM
	A2	LM	LM	LM	LM	LM	LS	LM	LV	LM	LV	LV	LM	LV	LV	LM
	A3	LM	LV	LM	LM	LV	LM	LV	LV	LM	LV	LM	LS	LV	LV	LM
	A4	LM	LM	LM	LS	LM	LS	LM	LM	NT	LS	LS	NT	LM	LM	NT
D3	A1	LM	LV	LM	LM	LV	LM	LM	LM	LS	LV	LM	LS	LV	LV	LS
	A2	LM	LM	LS	LV	LM	LS	LV	LV	LM	LV	LV	LS	LV	LV	LS
	A3	LM	LM	LM	LM	LV	LM	LV	LV	LM	LM	LV	LM	LM	LV	LM
	A4	LM	LM	NT	LM	LS	NT	LM	LM	NT	LM	LS	NT	LM	LS	NT
D4	A1	LS	LM	LS	LS	LM	LS	LV	LV	LS	LM	LV	LS	LM	LV	LS
	A2	LS	LM	LS	LS	LM	LM	LM	LM	LM	LS	LM	LS	LS	LM	LS
	A3	LM	LM	LM	LM	LV	LM	LM	LV	LM	LM	LM	LM	LM	LV	LM
	A4	LS	LM	NT	LS	LM	NT	LS	LM	NT	LS	LS	DS	LM	LS	DS
D5	A1	LM	LM	LS	LM	LV	LS	LV	LV	LM	LM	LV	LS	LV	LV	LS
	A2	LM	LV	LM	LS	LM	LM	LM	LM	LM	LM	LM	LS	LM	LM	LS
	A3	LS	LM	LS	LS	LV	LM	LM	LM	LM	LM	LM	LM	LM	LV	LM
	A4	LS	LM	NT	LS	LM	NT	LS	LS	NT	LS	LS	NT	LS	LS	NT
D6	A1	LM	LM	LS	LM	LV	LS	LV	LV	LM	LV	LV	LM	LM	LV	LS
	A2	LM	LM	LS	LS	LM	LS	LM	LM	LS	LS	LM	LS	LM	LM	LS
	A3	LM	LM	LM	LM	LM	LS	LM	LM	LS	LM	LM	LS	LM	LM	LM
	A4	LS	LS	NT	LS	LM	DS	LS	LM	DS	LS	LS	DS	LM	LM	DS
D7	A1	LM	LV	LM	LV	LV	LM	LM	LM	LS	LM	LV	LS	LM	LV	LS
	A2	LM	LM	LM	LM	LM	LM	LS	LM	LS	LM	LV	LM	LM	LV	LM
	A3	LM	LM	LM	LS	LM	LS	LS	LM	LS	LM	LM	LS	LM	LV	LS
	A4	LS	LM	DS	LS	LM	DS	LS	LM	DS	LM	LM	NT	LM	LM	NT

A1 = Cow's milk kefir enriched with encapsulated lavender volatile oil; A2 = Cow's milk kefir enriched with encapsulated mint volatile oil; A3 = Cow's milk kefir enriched with encapsulated fennel volatile oil; A4 = Control sample.

3.1.2. Determining the Criteria

According to the tester's opinion, the approval criteria for each alternative were calculated using Formula (2), so, for each alternative, the following results were obtained:

1. Day 1 of storage
   The results of the approval criteria for alternative 1 are =LS, LM, LM, LS, LM, LM and LM.
   The results of the approval criteria for alternative 2 are =LS, LM, LM, LS, LS, LS and LS.
   The results of the approval criteria for alternative 3 are =LM, LM, LM, LM, LS, LM and LS.
   The results of the approval criteria for alternative 4 are =LS, LS, LM, LS, LS, LS and LS.
2. Day 10 of storage
   The results of the approval criteria for alternative 1 are =LM, LV, LM, LM, LM, LM and LM.
   The results of the approval criteria for alternative 2 are =LM, LM, LM, LM, LM, LM and LM.
   The results of the approval criteria for alternative 3 are =LM, LM, LM, LM, LM, LM and LM.
   The results of the approval criteria for alternative 4 are =LM, LM, LS, LM, LS, LS and LM.
3. Day 20 of storage
   The results of the approval criteria for alternative 1 are =LM, LM, LS, LS, LS, LS and LS.

The results of the approval criteria for alternative 2 are =LS, LS, LS, LS, LM, LS and LS.
The results of the approval criteria for alternative 3 are =LM, LM, LM, LM, LS, LS and LS.
The results of the approval criteria for alternative 4 are =NT, NT, NT, NT, NT, DS and DS.

3.1.3. Determining the Tasters

Before calculating the approval process of a taster, we used Formula (3) to determine the value weights.

The value weights for Q1, Q2, Q3, Q4, Q5, Q6 and Q7 are DM, DS, NT, NT, LS, LM and LV, respectively.

We used Formula (4) to determine the process of approval of the tasters.

1. Day 1 of storage
   The result of the tasters' approval process for alternative 1 on day 1 is LS (Like slightly).
   The result of the tasters' approval process for alternative 2 on day 1 is LS (Like slightly).
   The result of the tasters' approval process for alternative 3 on day 1 is LS (Like slightly).
   The result of the tasters' approval process for alternative 4 on day 1 is LS (Like slightly).
2. Day 10 of storage
   The result of the tasters' approval process for alternative 1 on day 10 is LM (Like moderately).
   The result of the tasters' approval process for alternative 2 on day 10 is LM (Like moderately).
   The result of the tasters' approval process for alternative 3 on day 10 is LM (Like moderately).
   The result of the tasters' approval process for alternative 4 on day 10 is LS (Like slightly).
3. Day 20 of storage
   The result of the tasters' approval process for alternative 1 on day 20 is LS (Like slightly).
   The result of the tasters' approval process for alternative 2 on day 20 is LS (Like slightly).
   The result of the tasters' approval process for alternative 3 on day 20 is LS (Like slightly).
   The result of the tasters' approval process for alternative 4 on day 20 is NT (Neither like nor dislike).

The best results obtained from the sensory analysis of the kefir samples were obtained on day 10. On this day, the kefir samples enriched with volatile oils obtained the grade "Like moderately", and the control sample obtained the grade "Like slightly". On day 1, all sensory tests of the kefir samples obtained the grade "Like slightly". On day 20, the kefir samples enriched with volatile oils obtained the grade "Like slightly", and the control sample obtained the grade "Neither like nor dislike".

3.2. Texture Profile Analysis

Figure 1 shows the profile analysis of the kefir samples on the first day of storage. The control sample has the highest firmness of 152.53 g, and the kefir sample with volatile lavender oil has the lowest firmness of 125.56 g. The kefir sample with volatile mint oil has a firmness of 142.98 g, and the kefir sample with volatile fennel oil has a firmness of 131.56 g. A high firmness value can lead to increased syneresis over time. In terms of cohesiveness, the lowest value is recorded in the control sample of −25.67 g, and the highest value is recorded in the sample of kefir with volatile fennel oil of −17.76 g. The kefir sample with volatile lavender oil has a cohesiveness of −19.7 g, and the kefir sample with volatile mint oil has a cohesiveness of −22.53 g. Cohesion represents the negative values (which tend to infinity) of the retraction forces and represents the risk of syneresis. The control sample has the highest consistency of 3542.55 g·s, and the kefir sample with volatile fennel oil has the lowest consistency of 3034.3 g·s. The consistency of the kefir sample with volatile lavender oil is 3069.18 g·s, and the consistency of the kefir sample with volatile mint oil is 3178.04 g·s.

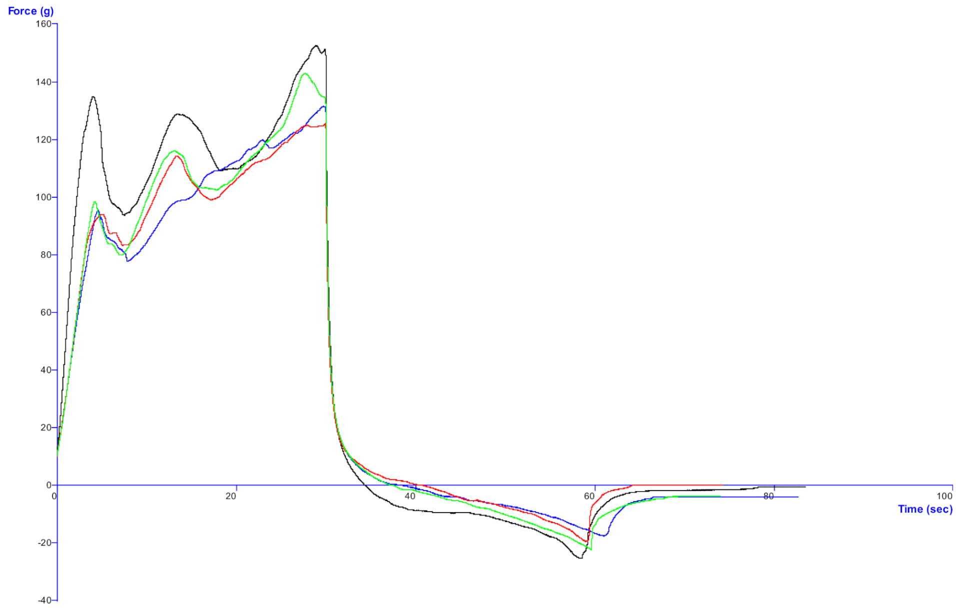

Figure 1. Analysis of the texture profile of kefir samples on the first day of storage.

where:

Red line—Cow's milk kefir enriched with encapsulated lavender volatile oil;
Green line—Cow's milk kefir enriched with encapsulated mint volatile oil;
Blue line—Cow's milk kefir enriched with encapsulated fennel volatile oil;
Black line—Control sample.

Figure 2 shows the analysis of the profile of the texture of kefir samples on the tenth day of storage. The sample of kefir with volatile lavender oil has the highest value of firmness of 160.34 g, and the sample of kefir with volatile fennel oil has the lowest value of firmness of 130.52 g. The kefir sample with volatile mint oil has a firmness of 141.21 g, and the control sample has a firmness of 149.84 g. The control sample has the lowest cohesiveness of −21.97 g, and the sample of kefir with volatile fennel oil has the highest cohesiveness of −16.41 g. The kefir sample with volatile lavender oil has a cohesiveness of −18.87 g, and the kefir sample with volatile mint oil has a cohesiveness of −20.82 g. The sample of kefir with volatile oil of lavender has the highest value of consistency of 4008.5 g·s, and the sample of kefir with volatile oil of fennel has the lowest value of consistency of 3263.12 g·s. The kefir sample with volatile mint oil has a consistency of 3530.25 g·s, and the control sample has a consistency of 3746.07 g·s.

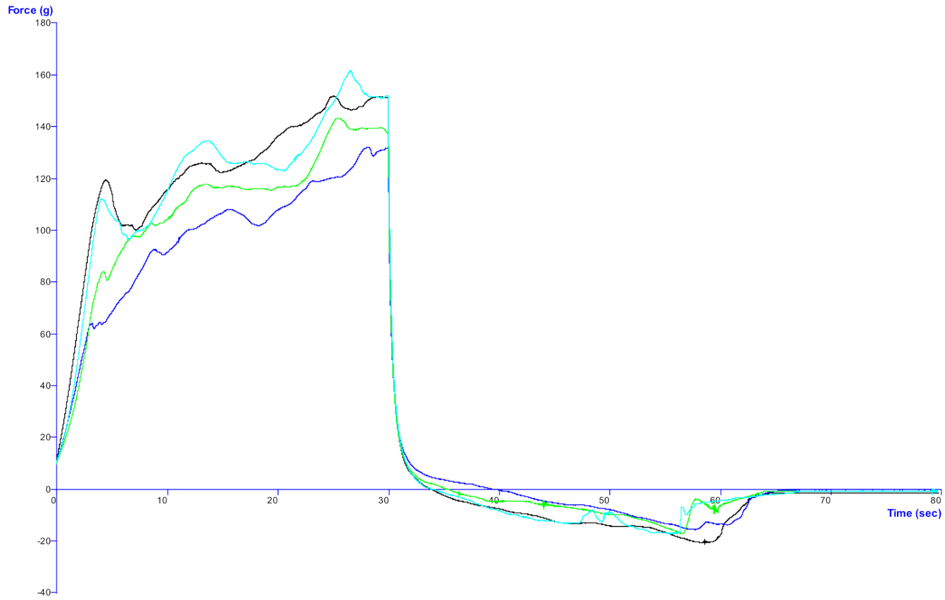

Figure 2. Analysis of the texture profile of kefir samples on the tenth day of storage.

where:

Light blue line—Cow's milk kefir enriched with encapsulated lavender volatile oil;
Green line—Cow's milk kefir enriched with encapsulated mint volatile oil;
Blue line—Cow's milk kefir enriched with encapsulated fennel volatile oil;
Black line—Control sample.

Figure 3 shows the profile analysis of the kefir samples on the twentieth day of storage. The kefir sample with volatile lavender oil has the highest value of firmness, 152.56 g, and the control sample has the lowest value of firmness, 109.58 g. The kefir sample with volatile mint oil has a firmness of 146.94 g, and the kefir sample with volatile fennel oil has a firmness of 147.43 g. The highest value of cohesiveness is recorded in the control sample of −12.95 g, and the lowest value is recorded in the kefir sample with volatile lavender oil of −22.89 g. The kefir sample with volatile mint oil has a cohesiveness of −20.82 g, and the kefir sample with volatile fennel oil has a cohesiveness of −18.86 g. The highest consistency is recorded in the kefir sample with volatile lavender oil, 3696.22 g·s, and the lowest consistency is recorded in the control sample of 2528.45 g·s. The kefir sample with volatile mint oil has a consistency of 3648.5 g·s, and the kefir sample with volatile fennel oil has a consistency of 3589.43 g·s.

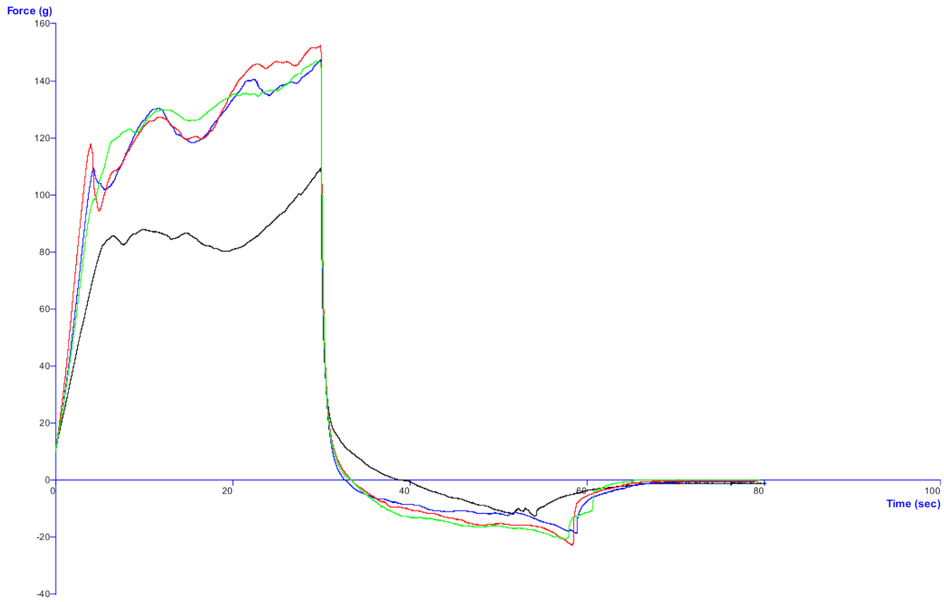

Figure 3. Analysis of the texture profile of kefir samples on the twentieth day of storage.

where:

Red line—Cow's milk kefir enriched with encapsulated lavender volatile oil;
Green line—Cow's milk kefir enriched with encapsulated mint volatile oil;
Blue line—Cow's milk kefir enriched with encapsulated fennel volatile oil;
Black line—Control sample.

4. Discussion

Four samples of cow's milk kefir were obtained, three with the addition of volatile oil of mint, lavender and fennel and one control sample. Studies have shown that volatile oils extracted from various herbs have antimicrobial and antioxidant properties. The volatile oils used were extracted with the help of the Neo-Clevenger device modified by Moritz, and the plants were harvested from crops in Sibiu County. In this study, the analysis of kefir samples from a sensory and textural point of view was considered.

For the sensory analysis, a team of seven amateur tasters was formed who regularly consume kefir, and the analysis periods were on the first day, on the 10th day and on the 20th day of storage. A non-numerical method based on several multi-personal approval criteria was used to interpret the results obtained. Following the sensory analysis, the results obtained show that for the kefir samples with volatile oils, the sensory characteristics are highlighted during storage; on day 10, the best grades are obtained, and by day 20, the characteristics begin to decrease, reaching those recorded on day 1 of the analysis. In the case of the control sample, the sensory characteristics are approximately stable in the first 10 days of storage, and then they begin to decrease, obtaining the lowest rating on day 20. The added volatile oils contributed to the kefir samples, as the sensory characteristics of these samples were much more appreciated compared to the control sample. The sensory characteristics of the kefir were influenced by the addition of volatile oils, improving them during its storage. Compared to the control sample whose characteristics deteriorated during storage, the kefir samples with volatile oils reached a peak of these characteristics on the tenth day of storage.

The analysis of the texture profile of the kefir samples was performed at room temperature (25 °C) using the texture analyzer TA.XT*plus*C. For this purpose, the firmness, consistency and cohesiveness of the four kefir samples were analyzed. The results obtained for the samples of kefir with encapsulated volatile oils are superior to those obtained in the case of the control sample, which indicates a higher elimination of whey during storage.

Thus, we can conclude that the added volatile oils bring not only a sensory aspect but also a physico-chemical aspect, because they influence the syneresis index.

The regular consumption of dairy products can prevent many cardiovascular diseases and digestive diseases. Kefir is a fermented dairy product highly appreciated by consumers, which is traditionally obtained with kefir grains consisting of a specific combination of yeast and bacteria.

Enrichment with bioactive components extracted from mint, fennel and lavender, in the form of encapsulated volatile oil, is a beneficial option for increasing the value of the product. The use of sodium alginate encapsulation ensures the stability of the volatile oils used. Due to the sensitivity of volatile oils to the action of environmental factors, it was decided to encapsulate them in sodium alginate and introduce them as spherical capsules to the dairy product. The amount of volatile oil extracted depends on the growing conditions and the soil and climatic conditions of the plants used. According to previous studies, it has been concluded that volatile oils have antimicrobial and antioxidant actions, representing an opportunity to use them in food products due to the health benefits brought to the consumer. Creating foods that contain natural antioxidants and antimicrobial compounds should be a priority in food management. Making foods that help boost the body's immunity or alleviate many chronic health problems is an effective and safe alternative to ensuring physical and mental health [35].

The use of volatile oils can eliminate the use of synthetic preservatives in dairy products because they have antimicrobial capacity. Food preservatives affect the health of consumers, often causing food poisoning [35].

In addition to the benefits of the products developed, they must be accepted by the consumer. The results obtained from the sensory and textural analysis certify an acceptance of kefir enriched with volatile oil of mint, fennel and lavender. All the results obtained in the case of these samples are superior to those obtained for the control sample in all three analysis periods.

5. Conclusions

Acidic dairy products are appreciated by consumers. They bring many benefits to the health of the consumer and can be consumed from an early age.

The kefir samples obtained were analyzed from a sensory point of view and a textural point of view. The sensory analysis was performed on the first day, on the 10th day and on the 20th day of storage of the kefir samples. A non-numerical method based on several multi-personal approval criteria was used to interpret the results obtained. The best results were obtained on the 10th day of storage, and the kefir samples enriched with volatile oils were much more appreciated compared to the control sample, to which volatile oils were not added.

The textural analysis analyzed the consistency, cohesiveness and firmness of the four kefir samples. The analysis period was identical to the one chosen for the sensory analysis. The results obtained for the samples of kefir with encapsulated volatile oils are superior to those obtained in the case of the control sample, which indicates a higher elimination of whey during storage.

We can conclude that the volatile oils added in both types of kefir positively influenced the sensory and textural characteristics of the finished product. The samples enriched with encapsulated volatile oils obtained superior results compared to the control sample in the case of both determinations performed.

All of these aspects show that the products analyzed, in addition to the beneficial action they bring to the consumer's health, are also accepted from a sensory point of view. The studied product is in accordance with the current trends due to the benefits for the health of the consumer by incorporating bioactive components.

Author Contributions: Conceptualization, M.A.T. and M.A.C.; methodology, M.A.T.; software, M.A.C.; validation, O.T., E.M., L.T. and V.B.; formal analysis, O.T.; investigation, M.A.T., M.A.C. and E.M.; resources, L.T. and V.B.; data curation, M.A.T. and O.T.; writing—original draft preparation,

M.A.C., M.A.T. and O.T.; writing—review and editing, E.M., L.T. and V.B.; visualization, M.A.T. and O.T.; supervision, M.A.T.; project administration, M.A.T.; funding acquisition, M.A.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Lucian Blaga University of Sibiu and Hasso Plattner Foundation, grant number LBUS-IRG-2020-06/No. 2841—16 July 2020.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We would like to express our sincere gratitude to the Research Center in Biotechnology and Food Engineering (C.C.B.I.A.), the Lucian Blaga University of Sibiu and the Hasso Plattner Foundation for their support provided throughout the research period.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Aryana, K.J.; Olson, D.W. A 100-Year Review: Yogurt and other cultured dairy products. *Int. J. Dairy Sci.* **2017**, *100*, 9987–10013. [CrossRef] [PubMed]
2. Segal, R. *Caracteristicile Nutriționale Ale Produselor Lactate Fermentate. Produse Lactate Fermentate*; Academica Galați: Galați, Romania, 2005; pp. 303–327.
3. Jeyakumari, A.; Zynudheen, A.; Parvathy, U. Microencapsulation of Bioactive Food Ingredients and Controlled Release—A Review. *MOJ Food Process Technol.* **2016**, *2*, 214–224.
4. Ben Said, L.; Gaudreau, H.; Dallaire, L.; Tessier, M.; Fliss, I. Bioprotective Culture: A New Generation of Food Additives for the Preservation of Food Quality and Safety. *Ind. Biotechnol.* **2019**, *15*, 138–147. [CrossRef]
5. Bătușaru, C.M. Sustainability of the small business environment in Romania in the context of increasing economic competitiveness. *Manag. Sustain. Dev.* **2019**, *11*, 37–41. [CrossRef]
6. Cu Toții Resimțim Stresul Cauzat De Coronavirus, Dar Părinții Și Minoritățile Sunt Printre Cei Mai Puternic Afectați. Câteva Modele De Implicare Din România. Available online: https://www.libertatea.ro/stiri/stres-coronavirus-parinti-minoritati-3016858 (accessed on 2 July 2020).
7. Tanu, B.; Harpreet, K. Benefits of essential oil: A review. *J. Chem. Pharm.* **2016**, *8*, 143–149.
8. Whiley, H.; Gaskin, S.; Schroder, T.; Ross, K. Antifungal properties of essential oils for improvement of indoor air quality: A review. *Rev. Environ. Health* **2018**, *33*, 63–76. [CrossRef]
9. Tița, O.; Constantinescu, A.M.; Tița, A.M. Antioxidant and Antiseptic Properties of Volatile Oils from Different Medicinal Plants: A Review. *Int. J. Pharmacogn. Chin. Med.* **2019**, *3*, 1–13.
10. Sayed-Ahmad, B.; Straumite, E.; Šabovics, M.; Kruma, Z.; Merah, O.; Saad, Z.; Hijazi, A.; Talou, T. Effect of addition of fennel (*Foeniculum vulgare* L.) on the quality of protein bread. *Proc. Latv. Acad.* **2017**, *71*, 509–514. [CrossRef]
11. Zeng, H.; Chen, X.; Liang, J. In Vitro antifungal activity and mechanism of essential oil from fennel (*Foeniculum vulgare* L.) on dermatophyte species. *J. Med. Microbiol.* **2015**, *64*, 93–103. [CrossRef]
12. Al-Okbi, S.Y.; Hussein, A.M.S.; Elbakry, H.F.H.; Fouda, K.A.; Mahmoud, K.F.; Hassan, M.E. Health benefits of fennel, rosemary volatile oils and their nano-forms in dyslipidemic rat model. *Pak. J. Biol. Sci.* **2018**, *21*, 348–358. [CrossRef]
13. Thompson, A.; Meah, D.; Ahmed, N.; Conniff-Jenkins, R.; Chileshe, E.; Phillips, C.O.; Claypole, T.C.; Forman, D.W.; Row, P.E. Comparison of the antibacterial activity of essential oils and extracts of medicinal and culinary herbs to investigate potential new treatments for irritable bowel syndrome. *BMC Complement. Altern. Med.* **2013**, *13*, 1–19. [CrossRef]
14. Salma, S.; Ramakrishnan, L.; Vinothini, J. Screening of antibacterial activity of five different spices (ajwain, coriander, cumin, fennel, and fenugreek) against pathogenic bacterial strains. *Asian J. Pharm. Clin. Res.* **2018**, *11*, 11–13.
15. Pande, K.R.; Preetha, R. Essential oil of fennel seeds as natural preservative in butter and its shelf life assessment. *Chem. Asian J.* **2017**, *29*, 711–714. [CrossRef]
16. Caputo, L.; Reguilon, M.D.; Mińarro, J.; De Feo, V.; Rodriguez-Arias, M. Lavandula angustifolia essential oil and linalool counteract social aversion induced by social defeat. *Molecules* **2018**, *23*, 2694. [CrossRef]
17. Sokovicx, M.; Glamoćlija, J.; Marin, P.D.; Brkić, D.; Van Griensven, L.J.L.D. Antibacterial effects of the essential oils of commonly consumed medicinal herbs using an in vitro model. *Molecules* **2010**, *15*, 7532–7546. [CrossRef]
18. Woronuk, G.; Demissie, Z.; Rheault, M.; Mahmoud, S. Biosynthesis and therapeutic properties of lavandula essential oil constituents. *Planta Med.* **2011**, *77*, 7–15. [CrossRef]
19. Benny, A.; Thomas, J. Essential Oils as Treatment Strategy for Alzheimer's Disease: Current and Future Perspectives. *Planta Med.* **2019**, *85*, 239–248.
20. Zhao, Y.; Chen, R.; Wang, Y.; Qing, C.; Wang, W.; Yang, Y. In Vitro and in Vivo Efficacy Studies of *Lavender angustifolia* Essential Oil and Its Active Constituents on the Proliferation of Human Prostate Cancer. *Integr. Cancer Ther.* **2017**, *16*, 215–226. [CrossRef]

21. Kunicka-Styczyńska, A.; Śmigielski, K.; Prusinowska, R.; Rajkowska, K.; Kuśmider, B.; Sikora, M. Preservative activity of lavender hydrosols in moisturizing body gels. *Lett. Appl.* **2015**, *60*, 27–32. [CrossRef]
22. Andrys, D.; Kulpa, D.; Grzeszczuk, M.; Bihun, M.; Dobrowolska, A. Antioxidant and antimicrobial activities of Lavandula angustifolia Mill. field-grown and propagated in vitro. *Folia Hortic.* **2017**, *29*, 161–180. [CrossRef]
23. Oroian, C.; Covrig, I.; Odagiu, A.; Mălinaș, C.; Moldovan, C.; Fleșeriu, A. Effects of cultivation systems and environmental conditions on peppermint (*Mentha* × *piperita* L.) biomass yield and oil content. *Not. Bot. Horti Agrobot. Cluj Napoca* **2017**, *45*, 576–581. [CrossRef]
24. Kennedy, D.; Okello, E.; Chazot, P.; Howes, M.J.; Ohiomokhare, S.; Jackson, P.; Haskell-Ramsay, C.; Khan, J.; Forster, J.; Wightman, E. Volatile Terpenes and Brain Function: Investigation of the Cognitive and Mood Effects of *Mentha* × *Piperita* L. Essential Oil with In Vitro Properties Relevant to Central Nervous System Function. *Nutrients* **2018**, *10*, 1029. [CrossRef]
25. Ramos, R.S.; Rodrigues, A.B.L.; Farias, A.L.F.; Simões, R.C.; Pinheiro, M.T.; Ferreira, R.M.A.; Barbosa, L.M.C.; Souto, R.N.P.; Fernandes, J.B.; Santos, L.S.; et al. Chemical composition and in vitro antioxidant, cytotoxic, antimicrobial, and larvicidal activities of the essential oil of *Mentha piperita* L. (Lamiaceae). *Hindawi* **2017**, *2017*, 1–9.
26. Singh, R.; Shushni, M.A.M.; Belkheir, A. Antibacterial and antioxidant activities of *Mentha piperita* L. *Arab. J. Chem.* **2015**, *8*, 322–328. [CrossRef]
27. Bellikci-Koyu, E.; Sarer-Yurekli, B.P.; Akyon, Y.; Aydin-Kose, F.; Karagozlu, C.; Ozgen, A.G.; Brinkmann, A.; Nitsche, A.; Ergunay, K.; Yilmaz, E.; et al. Effects of Regular Kefir Consumption on Gut Microbiota in Patients with Metabolic Syndrome: A Parallel-Group, Randomized, Controlled Study. *Nutrients* **2019**, *11*, 2089. [CrossRef]
28. Dimidi, E.; Cox, S.R.; Rossi, M.; Whelan, K. Fermented Foods: Definitions and Characteristics, Impact on the Gut Microbiota and Effects on Gastrointestinal Health and Disease. *Nutrients* **2019**, *11*, 1806. [CrossRef]
29. Windayani, N.; Kurniati, T.; Listiawati, M. Psychochemical and Organoleptic Characteristics of Colostrum Kefir as Antibacterial. *J. Phys. Conf. Ser.* **2019**, *1175*, 1–6. [CrossRef]
30. *Farmacopeea Română*, 10th ed.; Medicală: București, Romania, 1993.
31. Nussinovitch, A. *Hydrocolloid Applications: Gum Technology in the Food and Other Industries*; Chapman & Hall: London, UK, 1997.
32. Fadhil, R.; Agustina, R.; Hayati, R. Sensory Assessment of Sauerkraut Using a Non-Numeric Approach Based on Multi-Criteria and Multi-Person Aggregation. *Bull. Transilv.* **2020**, *13*, 112–118. [CrossRef]
33. Ye, X.; Sui, Z. Physicochemical properties and starch digestibility of Chinese noodles in relation to optimal cooking time. *Int. J. Biol* **2016**, *84*, 428–433. [CrossRef]
34. Measuring the Texture of Dairy Products. Available online: https://www.azom.com/article.aspx?ArticleID=19386 (accessed on 17 October 2020).
35. Tița, O.; Constantinescu, M.A.; Tița, M.A.; Georgescu, C. Use of yoghurt enhanced with volatile plant oils encapsulated in sodium alginate to increase the human body's immunity in the present fight against stress. *Int. J. Environ.* **2020**, *17*, 7588. [CrossRef]