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Investigation of heavy metal contamination and microbiological quality of massage oils sold in Türkiye

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Abstract

This study aimed to determine the heavy metal content and microbiological contamination levels of 10 aromatic massage oils containing different extracts selected by random sampling method. The ICP-MS technique was used to determine heavy metal levels. Aerobic mesophyll general bacteria, yeast and mold count, Enterobacteriaceae, coliform bacteria count, *Escherichia coli* count, and *Staphylococcus-Micrococcus* presence analyses were performed to determine microbiological contamination. The Analysis of massage oils revealed that none of the samples had yeast/mold, coliform bacteria *E. coli*. However, Enterobacteriaceae was grown in 2 samples, and *Staphylococcus-Micrococcus* was grown in 5. Arsenic was not detected in any of the massage oil samples. However, the presence of highly toxic heavy metals such as aluminum, lead, mercury, and cadmium in some samples was considered a concern. These results suggest that it will be important to monitor the production and marketing processes of the products more carefully and to review the existing standards, as massage oils may pose a public health problem.

Keywords: Aromatic Oils; Microbiology; Heavy Metal; Massage

1. Introduction

Massage is a method of mechanical action caused by the therapist's hands or devices on the body surface to improve the functional state of different tissues and organs through mechanical, reflex, humoral and bioenergetic action. Furthermore, millennial use, massage is widely used as a complementary and alternative therapy in daily life, sports, and medical care [1].

Oils of vegetable origin are often used to make the massage process more comfortable and enjoyable. Massage oils allow the therapist's hands to glide easily over the skin and can enhance the effect of the massage and moisturize the skin. On the other hand, massage oils are applied to the skin to reduce belly fat, improve circulation, reduce constipation, relieve blackheads, and tighten the skin. Massage oils are also believed to reduce cellulite, menstrual pain, body and joint pain, and scars [2]. The herbs in massage oil are reported to exhibit medicinal values such as antioxidant, antibacterial, anti-inflammatory, antimitotic and antiviral activities [3, 4, 5, 6].

Massage oils have an increasing use today. However, massage practices that people use to feel good and for treatment can actually pose a risk to their health at some points so the aim of this study has been to research the heavy metal contamination and microbiological quality of massage oil marketed in Türkiye.

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2. Material and methods

2.1. Material

Ten aromatic massage oils (Glycerin, Juniper Tar, Castor Oil, Centaury Oil, Mixed, Jasmine, Strawberry, Rose, Lemon and Mango) containing different extracts and belonging to different companies selected by random sampling methods from a nationwide e-commerce sites were collected in their original packaging and brought to our laboratory in this study. Microbiological and heavy metal, measurement analyses were carried out on the collected massage oils samples.

2.2. Microbiological Analysis

Aromatic massage oil samples (1 ml) was taken from the original packaging of the massage oils and added to 9 ml of sterile peptone water (containing Tween 80). Then, serial dilutions were prepared from the sample diluted at a ratio of 1:10, and cultures were made on the relevant media. For this purpose, aerobic mesophilic general bacteria count [7], yeast and mold count [8], coliform bacteria count [9], *Escherichia coli* count [10], Enterobacteriaceae count [11], Staphylococcus-Micrococcus group bacteria count [12] were performed.

2.3. Heavy Metal Analysis

Each of the massage oil samples (0.5 ml of) was taken into HP-100 Teflon containers and 10 ml of HNO3 (65%) was added and kept for 30 min. After the waiting period, 4 mL of HNO3 (65%) and 1 mL of hydrogen peroxide (30%) were added, and wet digestion was performed at 130 °C for 10 min, 150 °C for 5 min, 180 °C for 5 min and 200 °C for 10 min in a Sineo MDS-10 microwave system. After the procedure, the dissolved solutions were taken into 50 ml balloon jugs. The solution was diluted to 50 ml with ultra-distilled water. Samples taken into plastic tubes were kept in the refrigerator at +4 °C until the reading process. Agilent 7700 serial ICP-MS device was used to perform heavy metal analysis.

3. Results and discussion

Microbiological analysis results of the analyzed massage oils are shown in Table 1. As a result of the analyses performed on different massage oil samples, yeast/mold, coliform bacteria and *E. coli* were not detected in any sample. The total number of mesophilic aerobic bacteria in massage oil samples was 3.00 log cfu/ml in sample 1, 3.60 log cfu/ml in sample 4, 2.78 log cfu/ml in sample 5, 3.60 log cfu/ml in sample 6 and 2.78 log cfu/ml in sample 7. The number of Enterobacteriaceae in the analyzed massage oil samples was 2.3 log cfu/ml in sample 4 and 2.60 log cfu/ml in sample 5 and was not detected in other samples. *Staphylococcus* / *Micrococcus* count was 2.90 log cfu/ml in sample 1, 3.30 log cfu/ml in sample 4, 2.30 log cfu/ml in sample 5, 2.60 log cfu/ml in sample 6 and 7 of the massage oil samples.

In the studies, Okechalu et al. [13] determined the total number of aerobic bacteria in 60 palm oil analyzed as $9.4x10^4$ and $1.61x10^4$ cfu/ml. They also reported that they isolated *Enterobacter* spp, *Bacillus* spp, *Proteus* spp, *Micrococcus* spp, *Staphylococcus aureus*, *Aspergililus niger*, A. *flavus*, A. *fumigatus*, *Candida* spp, *Mucor* spp and *Penicillium* spp in the analyzed palm oil samples. Okechalu et al. [13] found that the total number of mesophilic bacteria detected in their study was higher than our study. In addition, different from our study, different mold and yeast species were also isolated. Barku et al. [14] did not detect *Salmonella* in the almond oils they analyzed. However, they reported the number of molds as 1.4×10^3 cfu/ml - 1.3×10^3 cfu/ml, and the total number of mesophilic bacteria as 4.0×10^3 cfu/ml - 4.8×10^3 cfu/ml. Barku et al. [14] detected a higher number of yeast and mold than our study, and the total bacteria level was found to be similar.

Although there is no clear definition of heavy metals, in general definitions, "density" and "negative effects on health" are emphasized [15]. Heavy metals are one of the most important pollutants that adversely affect the environment and living organisms [16]. Heavy metal levels in analyzed massage oils are shown in Table 2. As a result of the analyses performed on different massage oil samples, arsenic was not detected in any sample.

In our study, Li was detected at the levels of 2.19, 10.947, 34.336, and 1.303 ppb in 4 of the examined massage oil samples, while Li could not be detected in the remaining 6 samples. It has been determined that the massage oils containing Li contain glycerin, juniper tar, jasmine, and rose. In our search, no study was found on the Li contents of massage oils before.

While 225.27 ppb Al was detected in one of the massage oil samples examined in this study, Al could not be detected in the remaining nine samples. Al-containing massage oil was determined to contain jasmine. In our search, no previous study was found on the Al content of massage oils.

Table 1 Microbiological Analysis Results of Different Massage Oils (cfu/ml)

Sample	Mesophilic Aerobic Bacteria	Yeast/Mold	Enterobacteriaceae	*Coliform* Bacteria	*E. coli*	*Staphylococcus/ Micrococcus*
1 (Glycerin)	**3,00**	<2,00	<2,00	<2,00	<2,00	**2,90**
2 (Juniper Tar)	<2,00*	<2,00	<2,00	<2,00	<2,00	<2,00
3 (Castor Oil)	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00
4 (Centaury Oil)	**3,60**	<2,00	**2,30**	<2,00	<2,00	**3,30**
5 (Mixed)	**2,78**	<2,00	**2,60**	<2,00	<2,00	**2,30**
6 (Jasmine)	**3,60**	<2,00	<2,00	<2,00	<2,00	**2,60**
7 (Strawberry)	**2,78**	<2,00	<2,00	<2,00	<2,00	**2,60**
8 (Rose)	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00
9 (Lemon)	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00
10 (Mango)	<2,00	<2,00	<2,00	<2,00	<2,00	<2,00

*: <log 2.00 cfu/ml

Table 2 Heavy Metal levels of Massage Oils (ppb)

Sample	Li	Al	Cr	Fe	Cu	Zn	As	Ag	Cd	Hg	Pb
(Glycerin)	2,19	-*	-	-	-	-	-	-	5,373	1714,286	-
(Juniper Tar)	10,947	-	2026,398	274547,26	20,259	1039,58	-	-	6,226	-	-
(Castor Oil)	-	-	-	-	-	-	-	-	-	-	-
Centaury Oil)	-	-	15,533	-	-	-	-	-	-	-	873,863
(Mixed)	-	-	149,662	3371,992	56,552	-	-	-	-	1939,655	-
(Jasmine)	34,336	225,266	31,399	-	300,251	507,066	-	1,811	-	1120,69	-
(Strawberry)	-	-	-	-	-	-	-	-	-	-	-
(Rose)	1,303	-	29,275	-	-	-	-	-	-	-	-
(Lemon)	-	-	6,197	-	-	-	-	-	-	-	-
(Mango)	-	-	19,169	-	-	-	-	-	-	646,552	-

*-: Below the detection limit

While Cr was detected in 7 of the massage oil massage oil samples examined in our study, Cr could not be detected in the remaining 3 samples. It has been determined that the massage oil containing Cr contains Juniper tar, Centaury oil, mixed, jasmine, rose, lemon and mango. Cr could not be detected in other samples. Kabaran et al. [17] determined the

Cr level as 123.83±44.70 ppb in their study on olive oils. In our study, a wide range of Cr was detected as 2026.398, 15.533, 149.662, 31.399, 29.275, 6.197 and 19.169 ppb in the analyzed samples.

High iron concentration affects the flavor and oxidative stability of oils. The increase in Fe peroxide levels accelerates the oxidation of oil [18]. Zhu et al. [19] reported that the Fe level in the analyzed oils was found to be between 16200-45300 ppb in their study on heavy metal concentrations in nine types of edible vegetable oils consumed in China. Kabaran et al. [17], determined the Fe content as 875.06±806.85 ppb in his study on olive oils. In our study, Fe was found at 274547.26 to 3371,992 ppb levels only in juniper tar and mixed massage oils. It could not be detected in other analyzed samples.

Cu is one of the unwanted metal contaminants [20, 21]. In the massage oils analyzed in this study, Cu was determined as 20.259, 56,552 and 300,251 ppb only in the massage oils containing juniper tar, mixed and jasmine. It was not detected in other samples analyzed. Zhu et al. [19] reported that the Cu level was found to be between 214-875 ppb, depending on the type of oil, in their study on the heavy metal concentrations in nine types of edible vegetable oil consumed in China. Kabaran et al. [17], in a study on olive oils, Cu content was determined as 7.85±13.54 ppb.

While Zn was detected as 1039.58 ppb and 507.066 ppb in 2 of the massage oil samples examined in this study, Zn could not be detected in the remaining eight samples. It was determined that the massage oil containing Zn was Juniper tar and jasmine. In our search, no study was found on the Zn content of massage oils before. However, from studies on other oils, Kabaran et al. [17] in their study on olive oils, the Zn level was found to be 469.36±312.86 ppb. Zhu et al. [19] reported that the Zn level was between 742–2560 ppb in their study on heavy metal concentrations in nine types of edible vegetable oil.

In the massage oil samples examined in our study, 1.811 ppb silver was detected only in jasmine-containing massage oil.

The International Agency for Research on Cancer classifies cadmium and its compounds as group 1 carcinogens for humans [22]. In the massage oils analyzed in our study, 5.373 and 6.226 ppb were detected in massage oils containing glycerin and juniper tar.

In the massage oils analyzed in this study, 1714.286, 1939.655, 1120.69, and 646.552 ppb mercury were detected in massage oils containing glycerin, mixed, jasmine, and mango. Hg was not detected in other oils. This shows that three massage oils contain mercury above the permissible limit values in Türkiye [23], and all massage oils containing Hg contain mercury above the limit values according to Singapore regulations [24] .

Kabaran et al. [17] reported that the lead level was 27.72±28.77ppb in a study on olive oils. In the massage oils analyzed in our study, it was found to be 873.863 ppb only in massage oil containing Centaury oil.

4. Conclusion

According to the findings of the research, the analysis of the massage oils revealed that there was no yeast/mold, coliform bacteria *E. coli* in any of the samples. Still, there was Enterobacteriaceae growth in 2 samples and Staphylococci growth in 5 samples. Arsenic was not detected in any of the massage oil samples measured. The presence of highly toxic heavy metals such as aluminum, lead, mercury, and cadmium in some samples was seen as a cause for concern.

The presence of some toxic heavy metals, including mercury, in many samples, should be taken into consideration as it may pose a public health problem. Although massage therapies and massage oils have an increasing use, the lack of sufficient studies on the subject shows that further and detailed studies on these products are needed. With all these, it is suggested that standards should be prepared for massage oils, the production and use of which are rapidly increasing.

Compliance with ethical standards

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Summarized from the Master's Thesis of the same name (2022-038). This manuscript does not require IRB/IACUC approval because there are no human and animal participants. The data, information and documents presented in this article were obtained within the framework of academic and ethical rules.

Disclosure of conflict of interest

The authors declares no potential conflict of interest.

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