Al-Farouk journal of sciences
Volume (2), Issue (3) (JUNE, 2026)
ISSN: 3135-2359

مجلة الفاروق للعلوم
المجلد (2) ملحق العدد 3 يونيو 2026
ردمد: 3135-2359

Investigation of Formaldehyde in Selected Cosmetic Products from Local Markets in Al-Asaba City, Libya

Afaf M.A.Almaqtuf Aisha B.A. Almaqtuf

Afafalmagtuf @gmail .com Inter2011@yhoo.com

(2,1) Department of Chemistry, Faculty of Science / Al-Asabaa, Gharyan University

Received: 29/6/2026 Revised: 20/7/2026 Accepted: 28/7/2026 Publication: 10/8/2026

Abstract :

Organization (International Agency for Research on Cancer, IARC) as a Group 1 carcinogen. In cosmetics, formaldehyde may be used as a preservative provided that its concentration does not exceed 0.2%. This study aimed to detect and determine the presence of formaldehyde in selected cosmetic products available in the local markets of Al-Asaba City, Libya. The acetyl acetone method was employed, and absorbance was measured spectrophotometrically at a wavelength of 410 nm. A total of eleven samples were collected from commercial shops and pharmacies, including hair gel, hair cream, shampoo, deodorant, foundation cream, glycerin cream, eye shadow, nail hardener, shower gel, eyelash adhesive, and hand cream. The results revealed the absence of formaldehyde, as indicated by the lack of yellow coloration typically produced by the lutidine complex formed through the reaction of formaldehyde with ammonium acetate and acetyl acetone. However, the presence of formaldehyde-releasing agents in the samples cannot be excluded. The absorbance readings ranged between 0.016 and 0.0287 with the lowest values observed in hair cream and highest values in nail hardener.

Key words : cosmetics products , formaldehyde , spectrophotometer .

الملخص:

يصنف الفورم ألدهيد من قبل منظمة الصحة العالمية (الوكالة الدولية لبحوث السرطان) كمادة مسرطنة ضمن المجموعة الأولى يمكن إستخدام الفورم ألدهيد كمادة حافظة في المستحضرات التجميلية على ألا تتجاوز نسبته 0.2%.تهدف هذه الدراسة إلى الكشف عن الفورم ألدهيد وتحديده في بعض مستحضرات التجميل المتوفرة في السوق المحلية وذالك بإستخدام طريقة الأسيتل أسيتون ثم قياسها في جهاز المطياف الضوئي عند طول موجي 410 nm حيث تم جمع 11العينة من المحلات التجارية والصيدليات في مدينة الأصابعة وهي (جل شعر, كريم شعر , وشامبو شعر, مزيل عرق , كريم أساس , كريم جلسرين ,ظل عيون ,مقوي أضافر , جل إستحمام , لصقة الرموش ,كريم اليدين) و أظهرت النتائج خلو العينات لعدم ظهور اللون الأصفر الناتج من معقد اللوتيدين الذي يتكون نتيجة لتفاعل الفورم ألدهيد مع خلات الأمونيوم وأسيتل الأستون . ولكن ربما توجد بعض

المواد المحررة للفورم ألدهيد في العينات . حيث أن القراءات كانت مختلفة من (0.016 إلى 0.0287) . وكانت أقل قراءة في عينة كريم الشعر وأعلى قراءة في مقوي الأظافر.

كلمات مفتاحية : مستحضرات التجميل ، فورمالدهايد ، المطياف الضوئي .

Introduction :

Cosmetic products have been used since ancient times, even before the era of the Pharaohs, and were common in ancient Greek civilization and the Roman Empire. These materials are employed to enhance the appearance of the human body and are considered simple cleansers, with their use widespread across the world. The concept of using cosmetics whether substances or tools to beautify the external appearance of the body has remained unchanged throughout history . containing galena powder (lead sulfide, PbS) to darken their eyelids. Greek women applied toxic lead carbonate ($PbCO_3$) to achieve a pale complexion, red phosphorus for blush, and cinnabar (mercury sulfide, HgS) to color their lips. The basis of these early cosmetic preparations was metallic poisons such as lead, mercury, and arsenic. In traditional African societies, clay was ground into pastes for cosmetic use, while Australian Aboriginal communities continue to employ a wide variety of crushed rocks and minerals for body painting during ceremonies and cultural events**[1,2].** In recent years, the cosmetics industry has witnessed remarkable and significant development. It has expanded beyond the use of natural substances to include a wide range of chemical components **[3]**. According to the National Institute for Occupational Safety and Health (NIOSH) in the United States, more than 2,500 chemical substances present in cosmetic products are considered toxic and may cause eye and skin irritation, tumors, reproductive system disorders, and biological as well as genetic alterations in humans Chemical ingredients in cosmetics can enter the human body through multiple pathways. Powders are generally the least likely to penetrate the skin, whereas oil-based formulations or moisturizers allow greater absorption of chemicals through the epidermis. In contrast, hair sprays and perfumes, which are applied directly to the body and inhaled, can irritate the respiratory system**.[4]**

Many individuals use cosmetic products without being aware of their origin, composition, advantages, or potential adverse effects on the skin. It is essential to understand the benefits of each ingredient, its chemical function, and the permissible concentrations established for inclusion in cosmetic formulations. Furthermore, both the scientific and commercial names of each substance should be identified, along with the possible risks arising from interactions between different components **[5]** A wide variety of creams, mixtures, medications, and herbal preparations have been used for skin lightening, removal of spots, dark circles, scars, burns, and acne. However, repeated complaints have been reported by consumers regarding discomfort after the use of cosmetic products, particularly those applied to the face. Such discomfort is often associated with skin inflammation and allergic reactions to chemical substances in cosmetics, which are expected to be harmless to the skin. The severity of these reactions depends on the type of chemical compounds involved and the frequency of product use Excessive use of cosmetics in modern societies appears to have contributed to an increase in cases of dermatitis. Moreover, many cosmetic ingredients are not listed under the regulations of the U.S. Food and Drug Administration (FDA), as they have not undergone standardized testing, and their approval is often based on general public health considerations.

In addition, numerous cosmetic companies fail to disclose the full composition of their products, particularly when ingredients have not been tested. This highlights the importance of conducting necessary evaluations of therapeutic and cosmetic products to ensure consumer safety while also protecting the interests of cosmetic manufacturers The growing popularity of cosmetics, the diversity of formulations (herbal and non-herbal, medical and non-medical), and the increasing number of reported health issues resulting from their use emphasize the need for comprehensive studies on the composition of cosmetic products available in the market. Such studies should identify active compounds and other ingredients, as well as investigate their biological effects on the skin**.[6]**

Several international studies have investigated the presence of formaldehyde in cosmetic products using different analytical methods. A study conducted in China employed High-Performance Liquid Chromatography (HPLC) with 2,4-dinitrophenylhydrazine in 45% acetonitrile solution, revealing that 53% of the analyzed samples were positive for formaldehyde**[7–9]**. In Sweden, research at Lund University analyzed 42 cosmetic samples using HPLC, and the results indicated that the concentrations were within the permissible limits **[10].** Conversely, a study at Kashan University in Iran reported formaldehyde levels exceeding the allowable threshold in certain cosmetic and industrial detergent products, determined by HPLC with 2-methyl acetoacetanilide under specific temperature conditions **[11]**

At the University of Dhaka in Bangladesh, 75 cosmetic samples were examined using colorimetric analysis and HPLC, and some were found to contain measurable amounts of formaldehyde **[12].**

Similarly, a study in Indonesia investigated both locally manufactured and imported cosmetic products using Gas Chromatography–Mass Spectrometry (GC–MS) **[13]** and the findings showed that some products contained formaldehyde concentrations above the permissible limits. In Syria, research conducted at Tishreen University applied the acetylacetone method, and the results also demonstrated that certain cosmetic products contained formaldehyde levels higher than the allowable threshold **[14].**

Objectives of the Study:

The primary objective of this study is to determine the concentration of formaldehyde in selected cosmetic products commonly available in local markets and pharmacies in Al-Asaba City, Libya. Specifically, the study aims to:

1. Quantify formaldehyde levels in widely used cosmetic products to assess their safety .
2. Evaluate compliance of the detected concentrations with international and global regulatory standards.
3. Identify potential risks associated with elevated levels of formaldehyde in cosmetic.
4. Raise consumer awareness regarding the hazards of excessive formaldehyde exposure through cosmetic use .

Methodology :

Sample Collection:

A total of eleven cosmetic products were collected from local shops and pharmacies in Al-Asaba City, Libya. during the month of September 2024 . The samples included hair gel, hair cream, shampoo, deodorant, foundation cream, glycerin cream, eye shadow, nail hardener, shower gel, eyelash adhesive, and hand cream . as shown in the following table (1):

Table (1) Cosmetic Samples Used in the Study

Sample	Brand	Country of Origin
Glycerine Cream	Ronsy	Tunisia
BB Foundation	Note	Spain
Cream	Dove	Italy
Deodorant	Lifebuoy	Syria
Hair Shampoo	ToTEX	Turkey
Hair Gel	BBrose	Germany
Nail Hardener	Enchanteur	France
Shower Gel	Karseel	Italy
Hair Cream	Snonas	Spain
Hand Cream	Lanell	New York (USA)
Eye Shadow	Note	Italy

Chemicals and Reagents

- Formaldehyde solution (37%, CH_2O)
- Acetyl acetone ($C_5H_8O_2$)
- Ammonium acetate ($C_2H_7NO_2$)
- Sodium sulfate (Na_2SO_4)
- Distilled water

Tools and Instruments

- Volumetric flasks (50 mL)
- Test beakers (100 mL)
- Test tubes
- Analytical balance
- Water bath
- Centrifuge
- UV–Visible spectrophotometer

All glassware used in the analysis was thoroughly washed with tap water. The cleaned glassware was then immersed in a diluted solution of nitric acid (10%) for 24 hours .After immersion, the glassware was rinsed with tap water followed by deionized water. Finally, the glassware was dried and prepared for use in the experimental procedures.

Preparation of Solutions

Dissolve 150 g of ammonium acetate in distilled water. Add 3 mL of acetic acid followed by 2 mL of acetyl acetone. Dilute with distilled water to obtain a final volume of 1000 mL. Prepared in the same manner as above, but without the addition of acetyl acetone . The sodium sulfate solution was prepared by dissolve 25 g of sodium sulfate in 100 mL of distilled water.

Sample Preparation

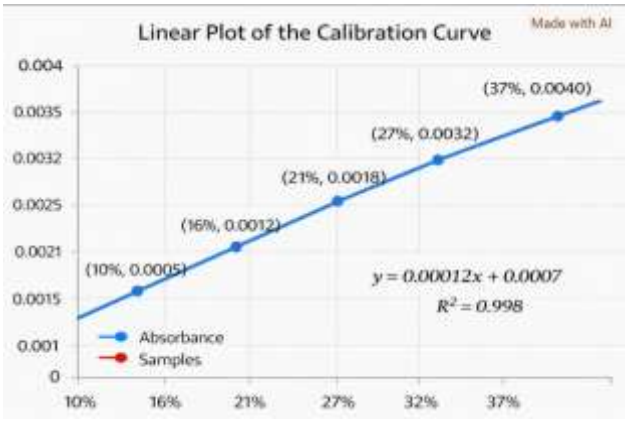
Extraction:

A 1 g portion of the cosmetic sample was accurately weighed and placed in a flask. 20 mL of 25% sodium sulfate solution was added, and the mixture was shaken thoroughly. Approximately 40 mL of distilled water was then added. The solution was heated in a water bath at 40 °C for 30 minut**es**. After heating, the sample was cooled and centrifuged for 10 minutes**.** The resulting aqueous extract contained formaldehyde for subsequent analysis .

To determine the concentration of formaldehyde, 5 mL of the aqueous extract was mixed with 5 mL of the derivatization solution, while another 5 mL portion of the same extract was combined with 5 mL of ammonium acetate solution as a control. Both mixtures were heated in a water bath at 40 °C for 30 minutes, then cooled to room temperature. The absorbance of the resulting solutions was measured using a UV–Visible spectrophotometer available in the college laboratory, which had been calibrated with appropriate formaldehyde standard solutions to ensure accuracy.

Preparation of Standard Solutions

A stock solution of 37% formaldehyde was prepared, from which six different concentrations (10%, 15%, 16%, 21%, 27%, and 37%) were obtained and distributed into twelve test tubes. For each concentration, 5 mL was mixed with 5 mL of the derivatization solution, while another 5 mL was combined with 5 mL of ammonium acetate solution. All mixtures were heated in a water bath at 40 °C for 30 minutes, then cooled to room temperature. The spectrophotometer was calibrated at a wavelength of 410 nm using these prepared standards to ensure accurate measurement of formaldehyde concentrations in the samples.



Results:

The cosmetic samples were analyzed using a UV–Visible spectrophotometer, and the absorbance readings obtained for each sample are presented in Table (2). These values represent the measured concentrations of formaldehyde in the tested products, which were later compared with international permissible limits to evaluate their safety .

Table (2): Absorbance Values of Cosmetic Samples

Sample No.	Sample Name	Absorbance in Ammonium Acetate (A1)		Absorbance in Derivatization Solution (A2)	Total Absorbance (A = A1 - A2)
1	Nail Hardener	0.0489		0.0193	0.0287
2	Deodorant	0.0335		0.0122	0.0213
3	Foundation Cream	0.0273		0.0167	0.0106
4	Eyelash Adhesive	0. 0362		0.0128	0.0234
5	Hair Shampoo	0.0959		0.0799	0.016
6	Hair Gel	0.0224		0.0113	0.0111
7	Eye Shadow	0.0457		0.0313	0.0144
8	Glycerine Cream	0.1607		0.1378	0.0229
9	Hair Cream	0.0037		0.0015	0.0022
10	Snonas Cream	0.0346		0.0235	0.0111
11	Shower Gel	0.0357		0.0273	0.0084

Calibration Curve Equation:

$Y = 0.00012x + 0.0007$

Rearranging to solve for concentration x:

$$X = \frac{y - 0.0007}{0.00012}$$

Table (3) : Concentration Values of Cosmetic Samples

Sample No.	Absorbance (y)	Calculated Concentration (x %)
1	0.0287	233.3
2	0.0213	171.7
3	0.0106	82.5
4	0.0234	189.5
5	0.016	95.8
6	0.0111	86.7
7	0.0144	114.2
8	0.0229	185.0
9	0.0022	12.5
10	0.0111	86.7
11	0.00 84	63.3

Table(4) : Concentrations after applying the **dilution factor 100**

Sample No	Absorbance (y)	Calculated concentration(x %)	Concentration after dilution100×
1	0.0287	233.3	23.330
2	0.0213	171.7	17.170
3	0.0106	82.5	8.250
4	0.0234	189.5	18.950
5	0.0160	95.8	9.580
6	0.0111	86.7	8.670
7	0.0144	114.5	11.420
8	0.0229	185.0	18.500
9	0.0022	12.5	1.250
10	0.0111	86.7	8.670
11	0.0084	63.3	6.330

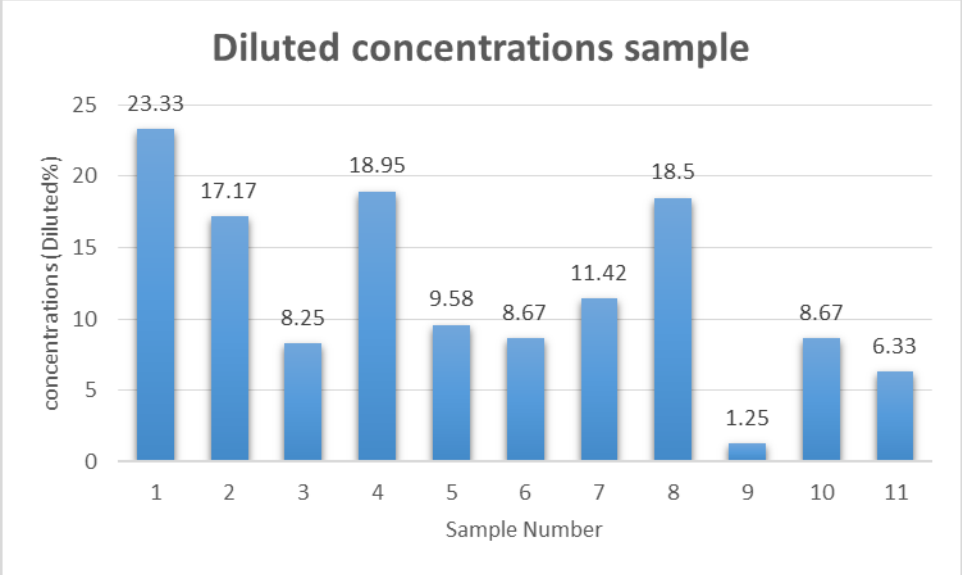


Diagram presenting formaldehyde levels in the investigated sample

Discussion:

Sample 1 exhibited the highest absorbance (0.0287) and consequently the highest concentration after dilution (23.330), indicating a significantly elevated content of the analyte. In contrast, Sample 9 showed the lowest absorbance (0.0022) and concentration (2,416), reflecting a markedly reduced level of the analyte. The remaining samples are distributed gradually between these extremes, highlighting natural variations among the tested samples. This distribution confirms the

validity of the calibration curve applied and suggests that the spectrophotometric method employed is reliable for quantitative analysis. The consistency of values before and after applying the 100-fold dilution factor further supports the accuracy of the methodology. From an analytical perspective, the results emphasize the sensitivity of the spectrophotometric technique in detecting differences in analyte concentrations across samples. Such findings are crucial for environmental and food safety studies, as they provide evidence of variability in chemical composition that may be linked to source conditions, contamination, or storage factors.

Conclusion :

In this study, the presence of formaldehyde in selected cosmetic products available in local markets and pharmacies was investigated using the acetylacetone method. A total of eleven samples were analyzed, and no direct evidence of formaldehyde was detected. However, some absorbance readings were relatively high, which may indicate the presence of preservatives or formaldehyde-releasing agents. Continuous exposure to such compounds through repeated use could potentially lead to adverse health effects over time. Therefore, it is recommended that strict monitoring and regulatory control be applied to cosmetic products, with routine screening for formaldehyde and related compounds. Furthermore, raising consumer awareness about the risks associated with long-term use of cosmetics containing hidden formaldehyde sources is essential to ensure public safety.

Recommendations :

Great caution should be exercised in the excessive use of cosmetic products, regardless of how simple they may appear, due to their potential harmful side effects associated with trace concentrations of formaldehyde. It is recommended to adopt studies based on international standard specifications for all types of cosmetics, conducted by specialists in cosmetic science, to support the advancement of scientific research. Adequate provision of instruments, facilities, and resources should be ensured to enable such investigations, while supplying researchers with the necessary information to achieve the best possible results in the shortest time. Consumers should be advised not to use any cream without prior consultation with a physician. Further studies are recommended to conduct quantitative determination of formaldehyde in other types of cosmetic products. It is essential to warn individuals working with keratin treatments about the potential hazards of formaldehyde exposur.

References:

[1] Jumana Al-Shawabkeh, (2012) *Cosmetic Chemistry*, Al-Yazouri Scientific Publishing, First Edition, p.151.

[2] Mais Ibrahim Darras, (2018) *Cosmetic Chemistry*, Amman, Academic Book Center, First Edition, pp.8–9.

[3] Chemist Abdul Wahab Al-Rifai, (2019) *Soap, Detergents, Shampoo, and Cosmetic Products for Skin and Hair*, Syrian Chemical Society.

[4] Baha Hamad Al-Masri, (2019) *Detergents and Cosmetic Products*, p.24.

[5] M. Areeb, R. Al-Bataineh, N. Ali, W. Al-Alami, (2011) *Special Vocational Sciences and Practical Training – Beauty Book*, Jordan Curriculum and School Books Administration, First Edition, pp.55–61.

[6] Engineer Basma Mohammed Othman, (2018) *Skin Chemistry*, Dar Alam Al-Thaqafa Publishing, pp.1, 12–13.

[7]- LU¨ Chunhua , HUANG Chaoqun , CHEN Mei , XIE Wen , CHEN Xiaomei (2012)Determination of free formaldehyde in cosmetics by pre-column derivatization, extraction inhibition and high performance liquid chromatography . College of Chemical Engineering and Materials Science, Zhejiang University of Technology, Hangzhou 310014, China.

[8]- Wu P, Chang C, Chou S. Determination of formaldehyde in cosmetics by HPLC method and acetylacetone method. J Food Drug Anal. 2003;11:8-15.

[9**]-** Kireche M, Peiffer J L, AntoniosD, Fabre I, Giménez-Arnau E, Pallardy M, Lepoittevin JP, et al. Evidence for chemical and cellular reactivities of the formaldehyde releaser bronopol, independent of formaldehyde release. Chem Res Toxicol. 2011;24:2115–2128.

[10]- Md. Motiur Rahman , Harun-or-Rashid , Subrata Bhadra and A. S. Shamsur Rouf (2015) Development and Validation of Colorimetric and RPHPLC Methods for the Determination of Formaldehyde in Cosmetics. Department of Pharmaceutical Technology, Faculty of Pharmacy, University of Dhaka, Dhaka-1000, Bangladesh.

[11]**-** Ali Gholami, Atefeh Mohsenikia, and Saeed Masoum (2016) Determination of Very Low Level of Free Formaldehyde in Liquid Detergents and Cosmetic Products Using Photoluminescence Method. Department of Analytical Chemistry, Faculty of Chemistry, University of Kashan, Kashan 87317-53153, Iran.

[12]- PAI-WEN WU, CHIEU-CHEN CHANG AND SHIN-SHOU CHOU (3003) Determination of Formaldehyde in Cosmetics by HPLC Method and Acetylacetone Method. Department of Health, Executive Yuan161-2, Kuan Yang Street, 115 Taipei, Taiwan.

[13]**-** Md. Motiur Rahman , Harun-or-Rashid , Subrata Bhadra and A. S. Shamsur Rouf Development and Validation of Colorimetric and RPHPLC Methods for the Determination of Formaldehyde in Cosmetics. American Chemical Science Journal 5(3): 224-237, 2015, Article no.ACSj.2015.022.

[14**]-** Ayat Abboud ,Dima Aldiab , Zein Alabdeen Khdar, Determination of formaldehyde in some cosmetics available in local market by acetylacetone method, Tishreen University Journal for Research and Scientific Studies 2017.