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Design, formulation and antimicrobial assessment of a traditional Iranian antiperspirant formula from *Rosa damascena* flowers and *Myrtus communis* leaves.

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Abstract

This study deals with the design and preparation of an antiperspirant formulation from traditional Iranian medicine containing aqueous decoctions of *Rosa damascena* Mill flowers and *Myrtus communis* L. leaves. The resulting product was evaluated for phytochemical content as well as physical, macroscopic, and rheological characteristics. Total tannin, total phenol, and total flavonoid contents were determined using standard spectrophotometric methods. The dilution method was used to reduce the concentration of antimicrobial protective components in the formulation and neutralize any residual activity. Most of the resulting formulated suspension products showed consistency in texture, a light brown appearance, and a pH value of 5.15. The total phenol content of *R. damascena* flower extract was determined as 219.1±3.42 mg GAE/g (mg gallic acid equivalent/gram of extract), and those of *M. communis* leaf extract and the final product were found to be 361.15±1.61 and 306.69 ±0.43 mg GAE/g respectively. Total flavonoid was 10.83±0.83 mg QE/g (mg quercetin equivalent/gram of extract) for *R. damascena* flower extract, 19.66±0.08 mg QE/g for M. Communis leaf extract, and 18.92±0.66 mg QE/g for the final product. The total tannin content of *R. damascena* flower extract was 137.92±1.17 mg QE/g, and those of *M. communis* leaf extract and the final product were 78.37±0.29 and 107.72±1.28 mg TA/g (mg tannic acid equivalent per gram of extract) respectively. The microbial threshold of the product was found to be quite perfectly within the permissible limit. Following pharmacopoeial and quality control assessments, the present formulation can be considered as a new health-therapeutic natural alternative for treating hyperhidrosis disorders.

Keywords: Antiperspirant formulation, *Rosa damascena*, *Myrtus communis*

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1. Introduction

Hyperhidrosis is a functional disorder of unknown etiology caused by excessive sympathetic nerve stimulation that stimulates the sweat glands and is directly controlled by the hypothalamus (1). Sweating is a vital function and is considered a body purifier, but any disruption to reduce

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or increase sweating causes physical and mental problems (2). Individuals with hyperhidrosis may face unwanted personal, occupational, and social consequences if carelessness and poor hygiene persist (3). In antiperspirant formulations, aluminum salts, especially aluminum chlorohydrate, a sweat duct blocker, are commonly used (4). Other metal salts used as antiperspirants include zirconium, iron, chromium, lead, mercury, and zinc salts, which are predominantly astringent, causing damage to proteins and thus blocking the secretory ducts. There is a wide range of therapies, including topical and general treatments, such as iontophoresis, injecting neural inhibitors, and surgical interventions (5, 6). Anticholinergic drugs relieve symptoms within two weeks but lead to dry mouth and nose, increased heart rate, sleep disturbances, constipation, urinary retention, and abdominal pain (7). Prescribing neural inhibitors has many side effects, including hematoma at the injection site and the weakening of hand muscles after injection, as well as neutralization of antibodies and, ultimately, resistance to the treatment. Moreover, the cost of treatment by this procedure is very high (8). Surgical procedures are recommended in severe cases, where patients fail to benefit from prior treatments, but the complications include wound infection, inflammation of sweat glands, scar formation, reduced sensitivity and hypoesthesia, pain, Horner's syndrome, and the risk of hemothorax and pneumothorax. Studies have demonstrated that the use of tannins in antiperspiration formulations can effectively prevent excessive perspiration (9). In traditional medicine, plants such as *M. communis* leaves, *R. damascena* flower, *Origanum majorana*, *Ocimum basilicum*, *Lawsonia inermis*, and *Glycyrrhiza glabra* leaves have been used as antiperspirants. The common active antiperspirant ingredient in all these plants is tannins (10), which are present in various parts of the plants, such as stems, sticks, leaves, fruits, seeds, and roots. Tannins are secondary metabolites that possess polyphenolic characteristics in higher plants and are generally characterized as antioxidant compounds. These compounds have shown promising impacts in treating a number of modern deadly diseases, including HIV, where they inhibit virus replication. Other tannin functions in the human body include antiviral, antibacterial, and antitumor properties (10). Plants containing tannins are effectively used to treat varicose veins, while many tannins also have vasoconstrictor properties (11). Among the tannin-bearing plants, *R. damascena* is composed of flavonoid components, such as kaempferol and quercetin, which is particularly worthy of investigation as they have declared diverse therapeutic properties (12). According to recent studies, *R. damascena* flowers display neuronal support and anticonvulsant, analgesic, and sedative effects on the nervous system (13, 14). Conversely, many studies have corroborated traditional medicine's recommendations, quoting that the *R. damascena* flower is known to accelerate and enhance heart contraction. Baskabadi *et al.* investigated the impact of hydroalcoholic extract of *R. damascena* flower on the guinea pig's heart and noticed an increase in the heart rate and strength (15). In another study, the *R. damascena* flower extract has shown an antitussive effect and dilating properties of the respiratory tract. Adding aqueous and alcoholic extracts of *R. damascena* flower to the respiratory air of guinea pigs reduced the increased cough frequency caused by the smell of citric acid and was found to be comparable to that of codeine (16). The myrtle, or *M. communis* is an evergreen species of flowering plants in the Myrtaceae family. This plant has a long history of use in traditional Iranian medicine to treat infections and inflammatory conditions, including sinusitis, bronchitis, prostatitis, and colds, and causes necrosis of proinflammatory cells (17). *M. communis* seeds, leaves, berries, and essential oils are rich in nutrients and bioactive substances with pronounced health benefits (18). Therefore, the present study aimed to design and prepare an antiperspirant formulation using *R. damascena* flower and *M. communis* leaf extracts based on various relevant formulations presented in Traditional Iranian Medicine's documentary resources.

2. Materials and Methods

The detailed and most relevant results were obtained from various ancient Iranian pharmaceutical documentary sources, including *Qarabadin-e-Salehi*, *-Kabir*, *-Kaderi*, *-Azam*, and *Makhzan-Al-Adwiya*. A sample procedure was selected and evaluated among those extracted from the above literature sources and used to prepare the final formulation. The criteria for selecting the formula were the fluidity of the final product, having

less than three components, and the ease of availability of the herbal components.

2.1. Plant material and traditional medicine sources

A prescribed formula from standard traditional documentary sources, including *R. damascena* flowers and *M. communis* leaves as ingredients, was selected for preparation. Three specimens of each plant material were purchased from three different authorized herbal pharmacies in Shiraz. The plant materials were identified by the senior plant taxonomist at the School of Pharmacy, and a voucher specimen of each plant material was deposited in the herbarium of the Department of Phytopharmaceuticals, School of Pharmacy, Shiraz University of Medical Sciences.

2.2. Preparation of aqueous extract

R. damascena flowers and *M. communis* leaves were powdered separately using a laboratory grinder. To prepare the aqueous extract, 45 g of powdered plant materials were added separately to boiling deionized water (1 liter) and extracted for 10 minutes. The extracts obtained were filtered and concentrated in a rotary evaporator under reduced pressure. The thick extract was then freeze-dried to remove trace moisture and residual solvent and stored at 4 °C prior to analysis.

2.3. Product formulation

Glycerin (10 ml) was added to 0.37 g of carbomer and mixed thoroughly using a homogenizer. Aqueous extract (50 ml) of each *R. damascena* flower and *M. communis* leaf was mixed, and the pH value of the mixture was determined over three time intervals and found to be 3.95, 3.94, and 3.93, respectively). To adjust pH value between 5.0-6.0, triethanolamine was add dropwise and the mixture was stirred. Zinc oxide nanoparticles with a ratio of 20%, 10%, and 2% were separately added to the mixtures and again stirred for 30 minutes using a homogenizer. Lavender essential oil and camphor were finally incorporated into each sample at a ratio of 0.5-1 % (w/v) and preferably 0.37% Carbomer 934P was used to reach a pharmaceutical suspension (a dispersion of nanoparticles in a gel) having a suitable degree of gelation (19). To avoid contamination, all samples were autoclaved before further analysis.

2.4. Physical and organoleptic tests

2.4.1. pH measurement

A solution containing one part of the prototype and nine parts deionized water was prepared, and the pH value of the solution was determined after the separate calibration of the device using two different standard buffer solutions (pH 4 and pH 7) in place of the highlighted part. (19).

2.4.2. Particle size determination

Determination of the particle size of the formulated products was conducted using dynamic light scattering (DLS) at two concentrations of 0.005 and 0.0005 of zinc nanoparticles, and the results were recorded accordingly (20).

2.4.3. Centrifugation test

The stability of the formulated suspension was monitored by centrifuging the samples at different speeds between 2,000 and 15,000 RPM. In this test, 5 to 10g of each sample was transferred into centrifugal glass tubes and separated at 2,000-5,000 RPM. The separation status of phases at different time intervals, ranging from 5-60 min, was examined (19).

2.4.4. Assessment of physical stability

The physical stability of the suspension formulation was determined at three different conditions: room temperature, refrigeration temperature, and 40 °C. Following the transfer of the sample into three separate test tubes, one tube was placed in the incubator at 25 °C, another at 4 °C, and the third tube at

40°C for six months to assess the physical stability of the samples. Samples were examined and compared in terms of appearance, color, smell, and roughness felt while in use on the skin. They were also examined for uniformity, homogeneity, and consistency change. The timing of each change was monitored accordingly. The rate and speed of phase separation were determined by measuring the volume of the separated phase. Formulations separated into phases were eliminated from the study (21).

2.4.5. Assessment of rheological behaviors

The cone and plate rheometer (Brookfield RC/S model) was used with a cone having a diameter of 50 mm (spindle C50-1). After placing the sample on the screen and lowering the device cone of the device, a 30-second pause was followed. This was until the effect of the force caused by the cone colliding with the plate was eliminated, and the formulation acquired its own shape. The distance between the cone and the plate was also 0.5 mm. The corresponding sample was applied with shear force at a velocity ranging from zero to 500 rpm. The average viscosity was measured accordingly. After that, the force diagram (Pascal) was drawn with respect to time (inverse second,

S-1). The Nivea product was used as a positive control to compare the viscosity of samples (22).

2.5. Antimicrobial preservative efficacy test

The preservative efficacy test was performed according to the US Pharmacopoeia (USP 41). Pathogenic microorganisms, including *Staphylococcus aureus*, *Escherichia coli*, *Candida albicans*, and *Pseudomonas aeruginosa* were added to the product at the concentration of 108 CFU/mL from the above microorganisms. On days 0, 7, 14, and 28 after inoculation, the number of colonies was counted and recorded (23).

2.6. Thin-layer chromatography (TLC)

In order to prepare the TLC profile of the samples, 2 mg of each extract was separately dissolved in 1 ml of methanol. This was used for this test. A 10 µl solution of each sample was loaded by an autosampler onto a silica gel 60 F254 type, 10×20 cm plate size at a distance of 1 cm, and dried in the air. The mobile phase (10 ml) was transferred into a TLC tank (Camag, Switzerland), the plate was run, and the solvent front distance was adjusted to 80 mm. After elution, the plates were dried in air and sprayed using a freshly prepared sulfuric acid-anisaldehyde reagent at room temperature and further heated to 110 °C in an oven until spots were visualized (24). To prepare the TLC reagent, 0.5 ml of anisaldehyde was dissolved in 10 ml of pure acetic acid in a volumetric flask. The volume was made up to 85 ml with methanol, and then 5 ml of pure sulfuric acid was added to get the reagent ready to use.

2.7. Measurement of total phenol content

Methanolic solutions of gallic acid with concentrations of 0.3, 0.15, 0.075, 0.01875, and 0.009375 mg/ml were prepared. The powdered plant (60 mg) was dissolved in 20 methanol and filtered. Five ml of various concentrations of the methanolic solution of gallic acid and the powdered plant in separate tubes were diluted with 2.5 ml of Folin-Ciocalteu reagent and mixed with 2 ml of sodium carbonate (75 g/l) and left in the dark for an hour at 20 °C, and then the absorption was read at 765 nm using a spectrophotometer (25).

2.8. Determunation of total flavonoid content

The Dowd method was used to measure flavonoid levels in the extracts. Two ml of the extract from steps 2-5 was mixed with 2 ml of 2% aluminum chloride. The mixture was left in the dark for 10 minutes at 25 °C. Later, the absorption was measured at 415 nm using a UV spectrophotometer. The flavonoid

Table 1. Macroscopic features of the formulated suspension containing plant extracts.

Spreadability	Color	Texture	Formulation
Passed	Light Brown	Uniform	Suspension

content of all samples was calculated in mg QE/g of extract, and the calibration curve was plotted accordingly (26).

2.9. Measurement of total tannin content

Three specimens of *R. damascena* flowers and *M. communis* leaf were initially evaluated for total tannin to select the specimen with the highest tannin content. The total tannin content of each sample was determined using the Folin-Denis method. According to this method, 0.5 ml of tannic acid was mixed with 0.5 ml of sodium carbonate (1 ml/mol), and the resulting mixture was homogenized in a vortex for 30 minutes. UV absorption of all samples was measured at 775 nm using a spectrophotometer (27). All measurements were conducted in triplicate.

3. Results

3.1. The Formulation suspension-Macroscopic features

The formulation prepared from *R.damascena* flower and *M. communis* leaf extracts in the form of a suspension showed a uniform texture and a light brown appearance (Table 1).

3.2. pH measurement

As shown in Table 2, no significant change was observed in pH values at different time frames. The results of pH measurement showed a pH value of 5.15 for the prepared formulations at different time intervals (Table 2), while a pH range between 4.0-7.0 is acceptable for topical products.

3.3. Particle size determination

Results of particle size determination showed that the nanoparticles used had a diameter of approximately 20 nm, which is considered an appropriate size for particles in a suspension. On the other hand, evaluation of nanoparticle properties in terms of physical stability and non-sediment properties in the long term and safety considerations for use on the skin showed that the composition had favorable conditions (Figure 1).

3.4. Results of Centrifugal test

The results of the centrifugal stability test revealed that no phase separation occurred at 37 °C, even at high RPMs of 3000, demonstrating the formation of a stable suspension.

3.5. Physical stability assessment

Formulations within six months of periodic stability assessment at room temperature showed acceptable stability and did not undergo phase separation. The consistency of the products remained constant, the smell of the formulations did not change compared to the time of manufacture, and there was no sensation of roughness on the skin, which is a sign of crystallization of the plant extract during storage.

3.5.1 Physical stability assessment at low tem-

Table 2. pH changes occurred in the prepared formulation at different time intervals

Formulation	At the time of Preparation	2 months after Preparation	4 months after Preparation	6 months after Preparation
Suspension	5.15	5.4	5.8	6.1
	5.17	5.3	5.9	6.3
	5.17	5.5	5.8	6.2
Passed	5.16±0.02	5.4±0.07	5.8±0.05	6.2±0.07

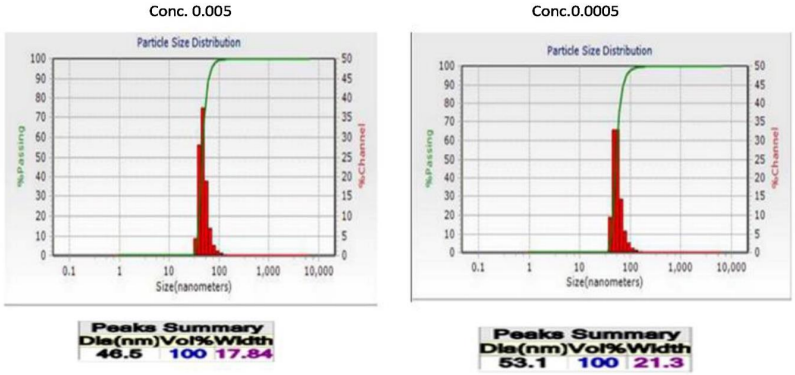

Figure 1. The particle size distribution of the sample using the DLS device.

perature

The formulation prepared was stable and did not crystallize at refrigerator temperature for six months of periodic stability assessment. It was observed that low temperature is desirable to maintain the stability of these suspension products during storage.

3.6. Assessment of rheological characteristics

The results of the rheological assessment of the formulated product showed that the Nivea compounds were a product with a high percentage of homogenization and had perfect consistency (Figure 2). Based on the results, it may be concluded that by selecting different percentages of carbomer and changing the technique, an almost perfect product with a high percentage of homogeneity and optimal viscosity was obtained. The results also showed that the sample containing 0.37% carbomer 934P showed the ideal rheological properties, including plasticity and proper degree of viscosity (Figure 2).

3.7. Antimicrobial preservative efficacy test

Results of antimicrobial efficacy tests The population of microorganisms decreased by 2 logarithmic units, and on day 28, no increase in the number of colonies was observed compared to day 14, which confirmed the antimicrobial effect of the product according to the US Pharmacopoeia (USP 41).

3.8. Results of thin-layer chromatography

A solution of 3 mg of each *R. damascena* and *M.communis* extract, as well as the final formulation in methanol, was used to prepare thin-layer chromatograms. Various solvent systems were tested to achieve proper elution and separation of the components on the chromatograms, and finally, ethyl acetate-methanol-formic acid (50:10:5) was selected as the suitable eluting solvent (Table 3, Figure 3).

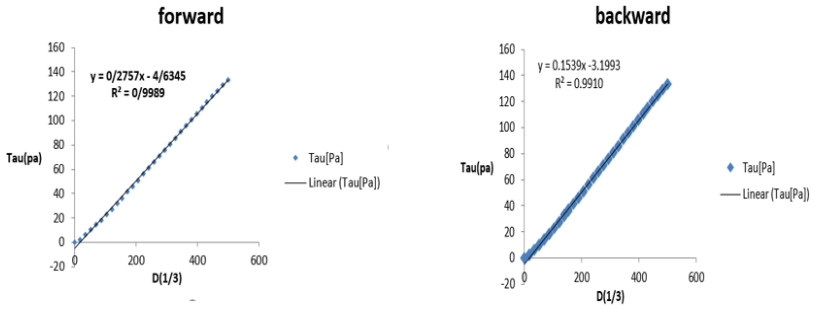

Figure 2. Results of the rheological properties of the final sample containing 0.37% carbomer 934P.

Table 3. Thin-layer Chromatographic solvent systems used.

No.	Solvent System	Description
1	Chloroform-Methanol (40:60)	Tailing
2	Water-Formic acid-Acetic acid-Ethylacetate (27:11:11:100)	NM*
3	Water-Formic acid-Ethylacetate (20:15:65)	NM
4	Pure Methanol	Tailing
5	Methanol-Chloroform- (80:20)	Tailing
6	Methanol-Chloroform- (80:40)	No proper Resolution
7	Water-Methanol-Formic acid-Ethylacetate (20:30:15:35)	NM
8	Methanol-Chloroform- (70:30)	Tailing
9	Methanol-Formic acid-Ethylacetate (30:10:50)	Tailing
10	Methanol-Formic acid-Ethylacetate (10:5:75)	NM
11	Toluene-Ethylacetate	Tailing
12	Methanol-Chloroform-Water (50:50:2)	NM
13	Ethylacetate-Methanol-Formic acid(50:10:5)	Ideal separation and resolution

* No movement

3.9. The Total phenolic content

The total phenol content of *R. damascena* flower extract was declared to be 42/3±1/219, and those of *M.communis* leaf extract and the product extract were 61/1±15/361 and 43/0±69/306, respectively (Figure 4, Table 4).

3.10. The total flavonoid content

The total flavonoid content of the flower extract was found to be 83/0±83/10, the total flavonoid content of *R. damascena* flower extract was 08/0±66/19, and the total flavonoid content of *R. damascena* flower extract was determined as 66/0± 92/18 (Figure 5, Table 5).

3.11. The total tannin content

The total tannin content of the *R.*

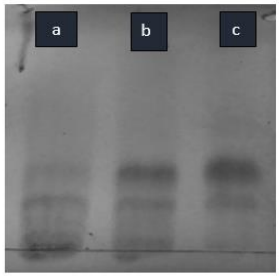

Figure 3. Thin-layer Chromatogram of the formulation, and *M. communis* leaf extract (a), *R. damascena* flower (b), and a mixture of both a and b (c).

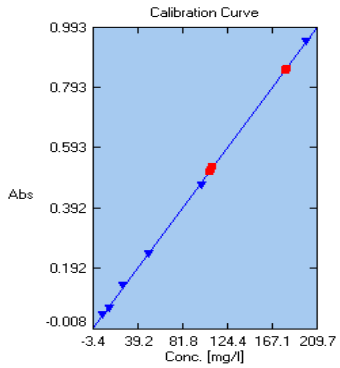

Figure 4. Total phenol content of *M. communis* leaf and *R. damascena* flower extracts and the product.

damascena flower extract was 17/1± 92/137, and those of the *M. communis* leaf extract and the product extract were 29/0±37/78 and 28/1±72/107, respectively (Figure 6, Table 6).

4. Discussion

Excessive sweating, which is not typically caused by heat or physical activities referred to as hyperhidrosis in dermatology. Despite the fact that this process is essential for removing waste metabolic materials from the body, excessive excretion not only reduces the effectiveness of the organ's proper functioning but is also displeasing to the individual's appearance. (1). Generally, abnormalities in the skin cause fluid loss, infection, hypothermia, ulcers, immune exposure, and gradual changes in body shape (28-31). The available treatment options are neural inhibitor injections, topical and general therapy, iontophoresis, and surgical interventions to decrease primary excretion (7). However, significant attempts have been made to develop heterogeneous ionic liquids to solve the inherent issues with these therapeutic modes. It is commonly accepted that the most effective and widely used basic ingredient in antiperspirant products is aluminum chlorohydroxide, which is safer and less corrosive than others and can be easily incorporated into a variety of antiperspirant products (32). Among these salts, only zinc salts are comparable to aluminum salts. The mechanism of action of metal antiperspirants is through entering the ducts of the eccrine glands, combining with creatine within the duct, leading to the atrophy of the secretory cells. This altered keratin will later fall off, and the sweat will return to its original state, al-

Table 4. test Total phenol content of *R. damascena* flower and *M. communis* leaf extracts and the formulated product in mg GAE/g ext.

Sample	Stock conc. mg/L	Total phenol in stock mg/L	Total phenol mg GAE/g of Ext. (AV±SD)
Rosa damascena aqueous extract	1000	222.66	219.10±3.42
		218.82	
		215.82	
Myrtus communis aqueous extract	1000	363.00	361.15±1.61
		360.44	
		360.02	
Rosa damascena and *Myrtus communis*	1000	306.70	306.69±0.43
		306.26	
		307.12	

* GAE:Gallic acid

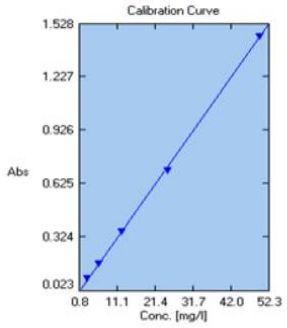

Figure 5. Total flavonoid content of M.communis leaf and R. damascena flower extracts and the product.

lowing the sweat ducts to resume their normal function (33). Long-term exposure to aluminum salts results in structural and functional degeneration of sweat glands (34). Hence, it is imperative to know the safety of their long-term use. In addition, hyperaluminemia has been reported as a consequence of long-term use and continuous exposure to these types of products (35). Some studies have also indicated that consumers of antiperspirants containing aluminum salts are at increased risk of breast cancer (28). Additionally, the absorption of aluminum and its association with Alzheimer's in consumers of such products have yet to be established (36). Hence, it has been shown in extensive studies that the integration of the above-mentioned formulas with tannins in formulations has resulted in satisfactory results in preventing excessive sweating (37). In the present study, the antiperspirant formulations presented in traditional Iranian pharmaceuticals were thoroughly studied, and ultimately, a relevant formulation was designed and prepared using *R. damascena* flowers and *M. communis* leaf extracts. The results of this study showed that in the prepared formulation, the total phenol content of *R. damascena* flower extract was 219.1±0.42 GAE/g of extract, and the total flavonoid and total tannin contents were found to be 10.83±0.83 QE/g, and 137.92±1.17 GAE/g of extract respectively, which can, therefore, be considered as a product with the appropriate effects. The formulation product in this study also showed the total phenol content of *M. communis* leaf extract at 361.15±1.61 while the total flavonoid content was 18.29±0.66 QE/g, and the total tannin content was found to be 78.37±0.29 TAE/g. These results may add additional pieces of evidence to support the favorable effects of this drug formulation. Therefore, a meaningful relationship was observed between tannin

Table 5. Total flavonoid content of *R. damascena* flower and *M. communis* leaf extracts and the formulated product in mg quercetin/g ext.

Sample	Stock conc. mg/L	Total flavonoid in stock mg/L	Total flavonoid mg QE/g of Ext. (AV±SD)
Rosa damascena aqueous extract	1000	11.66	10.83±0.83
		10.86	
		9.98	
Myrtus communis aqueous extract	1000	19.74	19.66±0.08
		19.58	
		19.68	
Rosa damascena	1000	19.34	18.92±0.66
+		19.28	
Myrtus communis extracts		18.16	

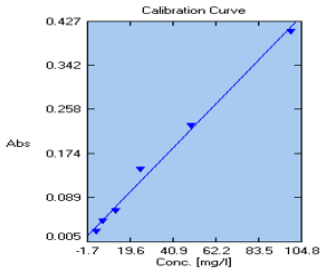

Figure 6. The total tannin content of *M. communis* leaf and *R. damascena* flower extracts and the product.

content in a product. A potential advantage of this formulation is its antimicrobial properties. This may be attributed to the high tannin content of both the herbal ingredients and the formulation. This allows the formulation to be prepared without industrial or synthetic antimicrobial preservatives. An examination of the color and aroma characteristics of the formulation revealed that the product is effective as an antiperspirant product while remaining simple and cost-effective (38).

The phenol content of the extracts prepared from *R. damascena* flowers and *M. communis* leaf extracts was found to be 219.1±3.42 and 361.15±1.61 respectively, while that of the formulation was 306.69±0.43 mg/ml. Furthermore, the present formulation was superior in terms of its total phenol, flavonoid, and tannin contents. These contents are considered significant criteria for the therapeutic as well as cosmetic effects.

In preparing the antiperspirant formulation, a topical product uses zinc oxide nanoparticles as an additive. These nanoparticles can have synergistic effects with *R. canina* extract. Numerous studies have demonstrated the benefits of aluminum salts in antiperspirant formulations (34). However, due to their metallic nature, patients may experience unwanted side effects if these compounds are applied topically for a long time. Continuous and long-term studies have shown the association between this compound and Alzheimer's disease, cancer, and hyperaluminemia. As a consequence, this study replaced zinc oxide with superior additives for antiperspirant formulations (39). Although zinc oxide has not been studied for antiperspirant properties, its use in other medical fields has been established. Due to its antibacterial properties, zinc oxide is used in medicine, hygiene products, skin ointments, and sunscreens. Additionally, this compound has shown promising results in the treatment of infection-prone

Table 6. Total phenol content of *R. damascena* flower and *M. communis* leaf extracts and the formulated product in mg GAE/g ext.

Sample	Stock conc. (mg/L)	Total Tannin in Stock (mg/L)	Total Tannin mg *TA/g of Ext. (AV±SD)
Rosa damascena aqueous extract	1000	136.56	137.92±1.17
		138.06	
		138.06	
Myrtus communis aqueous extract	1000	78.54	78.37±0.29
		78.04	
		78.40	
Rosa damascena	1000	109.08	107.72±1.28
+		107.56	
Myrtus communis extracts		106.54	

* TA:Tannic acid

lesions such as burns, eczema, and mild skin inflammation (40,41). Using zinc oxide as part of the prepared formulation had a significant impact on viscosity and stability. While both *R. damascena* flower and *M. communis* leaf extracts contributed to improving the formulation aroma by their individual profiles of aromatic compounds, essential oils such as lavender (1%) and camphor (1%) were also added to upgrade the formulation aroma. The essential oil of lavender has numerous therapeutic properties, including anti-inflammatory and sedative properties, and is used as an antiseptic in the treatment of wounds and burns (42). Lavender oil, which exhibits antioxidant properties, gave the final formulation an improved and pleasant aroma (43). The formulations evaluated in this study were assessed based on their microbial content after the autoclave process within 15 days and 30 days following the autoclave process. The results of this study indicated that the formulations were devoid of any microbial contamination and, therefore, could be considered acceptable in this regard. Obviously, increasing the number of microbial assessments over longer intervals can be useful. To verify the sustainability of the product for up to 2 years. The results of the pH measurement of the compounds used in this study showed that the pH of the compounds used remained in the range of 5.15 (The range 5.3-7.0 are acceptable pH values for topical products). Furthermore, regarding the role of particle size, the present study explored that nanoparticles of 50 nm incorporated in the formulation are considered desirable. On the other hand, the evaluation of nanoparticle properties in terms of physical stability and non-sediment in long-term sedimentation and topical safety considerations showed that the composition had favorable physicochemical characteristics. An analysis of the samples' rheological properties showed that the compounds used in this study had viscosity under favorable conditions. It is noteworthy that no relevant studies on these plants and their products have been reported. This may be considered a sign of the present study's uniqueness. It is worth mentioning that other antiperspirants have been studied earlier, some of which are mentioned in this section. A study examined a formulated antiperspirant product from *Parrotia persica* (DC.) C.A.Mey. by preliminary clinical examination using 70% ethanol-percolated extract (37). The type of tannin was identified by the microchemical method, and the tannin content was determined by the spectrophotometric method. The Rolands formulation was prepared from dry extract as an antiperspirant for the clinical study. Particular proportions of glycerin, propylene glycol, ethanol, water, carbopol, antioxidants, and preservatives were mixed with 5% leaf extract to reach an appropriate viscosity. The physical and chemical stability of the product was assessed within five months. The results showed that the plant's leaf tannins belong structurally to the pyrogallol series with a concentration of 61.11 percent. The product showed proper stability and decreased sweating rates in a clinical study in which 85% of volunteers consumed the product under the armpit (37). Other studies on antiperspirants examined and compared two antiperspirant formulations containing aluminum salts and gallic acid (44).

5. Conclusion

Previous studies, along with the beneficial properties of these two components in reducing sweating and thus improving the health conditions of consumers, can be considered as an additional advantage in the production of antiperspirant products of plant origin. Considering that the product composition is relatively simple and consists of two herbal components, it may be used as an effective lead in the preparation of a wide range of antidiabetic products suitable for various consumers. Therefore, considering this study's results, it can be concluded that the formulations prepared were based on the high content of tannins, phenols, and flavonoids. These for-

mulations were based on their desirable pharmaceutical properties. Moreover, it can be considered an innovative treatment strategy in the management of sweating disorders. This reveals this product's exact mechanism of action and requires further extensive studies and clinical trials.

Statistical analysis

Values are presented as mean±SD. SPSS software version 25 (IBM, Chicago, IL, USA) was used to perform the statistical analysis. Analysis of Variance (ANOVA) was employed to determine the significance of the difference between the results.

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Authors contributions

The study conception and design were performed by Mohammad Mehdi Zarshenas and Gholamhossein Yousefi. Data collection was conducted by Maryam Alipanah. Zahra Sobhani, Maryam Alipanah, Mohammad Mehdi Zarshenas, Mohammad Ali Farboodniay Jahromi, and Gholamhossein Yousefi conducted the data analysis and interpretation. Maryam Alipanah, Mohammad Ali Farboodniay Jahromi, Mohammad Mehdi Zarshenas, and Gholamhossein Yousefi, all contributed to the manuscript's drafting and critical review.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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