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Formulation and Physicochemical Evaluation of Anti-Ageing Polyherbal Powdered Facial Mask

Eva Jourdain[1,2], Mogana Rajagopal[1], Puay-Luan Tan[1]*, Kushagra Khanna[1], Rubhan Chandran[1]

[1] *Faculty of Pharmaceutical Sciences, UCSI University, No.1, Jalan UCSI, UCSI Heights, Cheras 56000 Kuala Lumpur, Malaysia*
[2] *Institute Agro Dijon, 26, Boulevard Docteur Petitjean, 21000 Dijon, France*

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ABSTRACT

Facial mask plays an important role in skincare routines due to its immediate effect on the skin and ease of use. Consumer awareness of the adverse effects of synthetic ingredients encourages the development of green cosmetics to meet consumer demand and achieve sustainability. Hence, facial masks without synthetic ingredients would gain more public preference. This study aimed to formulate and evaluate a new polyherbal powdered facial mask for anti-ageing effects. The polyherbal powdered facial mask was formulated using tomato powder, turmeric powder, and chickpea flour. The polyherbal powdered facial mask and the marketed mask were evaluated for organoleptic characteristics, particle size, pH, spreadability, flowability, and loss on drying. Heavy metal tests and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay were also conducted for the polyherbal mask. The polyherbal mask was cosmetically acceptable and skin-friendly due to its optimal pH (5.31 ± 0.13), spreadability (100 g: 3.93 ± 0.05 cm; 200 g: 4.37 ± 0.17 cm), flowability (angle of repose: 35.47 ± 1.90º; bulk density: 0.36 ± 0.03 g/cm^3; Hausner's ratio: 1.00 ± 0.0001; Carr's index: 0.25 ± 0.01%) and water content (LOD: 0.90 ± 0.08%). Heavy metal tests demonstrated that the polyherbal mask was free from cadmium and lead. In addition, turmeric contributes to the antioxidant activity of the polyherbal mask. In conclusion, the polyherbal powdered facial mask is a safe and effective alternative to the marketed mask for anti-ageing effects.

Keywords: Polyherbal, Facial mask, Tomato, Turmeric, Chickpea, *Curcuma longa* L., *Cicer arietinum, Solanum lycopersicum.*

Introduction

A cosmetic product is any substance or preparation intended to be applied to various external parts of the human body (epidermis, lips, etc.) to improve physical appearance.[1] It includes products for skincare, make-up, hair care, personal hygiene and perfumes. There has been a noticeable rise in the purchase of skincare products after the pandemic although the sales of make-up products declined during the outbreak of COVID-19.[2] Facial masks are easy to use and produce an immediate effect on the skin, thus, they have become an integral part of skincare routines.[3] Rinse-off masks, sheet masks, removable film, and gel masks are some examples of facial masks available in the market.[3]
The cosmetics sector is growing worldwide regardless of nationality, gender, race, and religion. The market value of facial masks was USD 32.76 billion in 2018 and is expected to reach USD 51 billion by 2025.[4] In 2021, the market size of natural skin care products achieved USD 6.7 billion globally. Among all the skincare products, facial care products contributed to 71.8% of the market size. The market size is forecasted to increase at a compound annual growth rate (CAGR) of 6.6% from 2022 to 2023.

*Corresponding author. Email: tanpuayluan@gmail.com
Tel: +603-91018880

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Moreover, there is an increased public awareness of the safety of natural products and environmental issues caused by synthetic ingredients such as sodium lauryl sulphate (SLS), parabens, sulphides, and alcohol in cosmetics.[5] Potential carcinogens in cosmetics are mainly ethanolamines, formaldehyde, parabens, tert-butyl compounds, ethoxylated compounds, and heavy metals. Hence, selecting cosmetic products with careful consideration of the ingredient list is crucial.[6]
The present study aimed to formulate a natural polyherbal powdered facial mask containing chickpea flour, tomato powder, and turmeric powder. The polyherbal mask was formulated without synthetic ingredients such as SLS, alcohols, parabens, and sulphides due to the risk of adverse skin reactions. Turmeric is reported to have anti-inflammatory and antioxidant properties for anti-ageing effects, anti-microbial properties for managing blemishes, anti-tyrosinase properties for pigmentation control, and photoprotective effects.[7–12] Hence, turmeric may be used as an antioxidant instead of retinoids that frequently cause itching, redness, and scaling of the skin.[13] Besides, turmeric has the potential to be used as an alternative to sodium metabisulphite to prevent oxidation, rancidity, and microbial growth in cosmetics products. It also promotes wound healing, heals acne, and brightens skin tone.[14] Tomato possesses antioxidant, anti-ageing, and photoprotective properties. Chickpea flour replaces synthetic carbomers such as sodium acrylate copolymer and polyethylene glycol (PEG), which may contain the potentially carcinogenic 1,4 dioxane. Chickpea flour contains 16.1 to 25.5% proteins, such as globulins and albumins which possess emulsifying and gelling properties.[15] The starch contained in the chickpea flour acts as a thickener that increases the viscosity of the mask after mixing with water.[16] Chickpeas are also cosmetically used for skin brightening and the management of skin infection, acne, and chloasma.[14] It was hypothesized that a polyherbal powdered facial mask that is cosmetically acceptable, easy to use, pleasant to apply, effective, and safe for consumers is developed for anti-ageing effects.

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Materials and Methods

Materials

Chickpea flour, turmeric powder, tomatoes, Lemasque Orange Peel Off Rubber Mask, 2,2-Diphenyl-1-picrylhydrazyl (DPPH), methanol and dimethyl sulfoxide (DMSO) for analysis of EMSURE® ACS, denatured 95% ethanol, cadmium pure standard 1,000 µg/mL, 2% HNO_3 and lead pure standard 1,000 µg/mL, 2% HNO_3.

Equipment

Analytical balance, Young Ji homogeniser, pH meter, microcentrifuge, microplate reader, sonicator, microscope equipped with camera, 100 g and 200 g calibration weight, atomic absorption spectrophotometer, lamps for cadmium, lamps for lead, oven and autoclave.

Preparation of freeze-dried tomato powder

The tomatoes were cut into half parallel to the stalks after the skin of the tomatoes was removed. Then, the seeds were removed and separated from the surrounding locular gel. The tomato pulp and locular gel were blended using a blender and then freeze-dried. The freeze-dried tomato powder was grinded using a mortar and pestle and stored in the freezer at -18°C.

Formulation of polyherbal powdered facial mask

The polyherbal powdered facial mask composed of 58.6% chickpea flour, 39.1% tomato powder and 2.3% turmeric powder. The polyherbal mask was formulated by grinding the tomato powder, chickpea flour, and turmeric powder in a mortar and pestle until a homogenous powder was obtained. The formula of the polyherbal powdered facial mask was created by considering the synergistic effects of tomato powder, chickpea flour, and turmeric powder in scavenging free radicals.

Organoleptic characteristics

The powder and paste form of the polyherbal powdered facial mask and the marketed mask (Lemasque Orange Peel Off Rubber Mask) were evaluated for four aspects (smell, colour, texture, and application). A RAL colour chart was used to identify the colour of the masks. Texture assessment was done by visually assess the coarseness of the powder and the sensation of grains on the skin. The sensation of grains was classified into thick grains (like a sugar or salt scrub), slightly thick grains (like coffee grounds), light grains (like honey), and no sensation of grains (like a clay mask). Lastly, the mask in paste form was spread and remained on the forearm for 10 minutes to assess the ease of removal after application.

Particle size determination

A microscope (Nikon, eclipse 50i) equipped with a camera (Nikon, DS-Fi1) and NIS-elements D 3.0 software was used for particle size determination. The particle size was determined under the microscope at 40x magnification. Thirty measurements were taken for individual ingredients, polyherbal powdered facial mask, and the marketed mask to obtain the average particle size (µm) ± standard deviation (SD).

pH determination

pH 4, 7, and 10 standard buffers were used to calibrate the pH meter prior to pH measurement. A 2% dilution of individual ingredients, polyherbal mask, and marketed mask was prepared by mixing 0.1 g powder with 4.9 mL water using a homogeniser.[17] Once the suspension was homogenised, the pH was measured five times and recorded to obtain the average pH ± SD of the suspension.

Spreadability

A total of 0.5 g polyherbal powdered facial mask and marketed mask in the paste form was measured and placed on a 1 cm diameter circle drawn at the centre of a glass slide. Then, a second glass slide was placed parallel to the first slide. Two weights (100 g and 200 g) were placed on the slide for 2 minutes at room temperature, i.e. 25°C. The diameter of the spread of the mask (cm) was measured for three times to obtain the mean diameter (cm) ± SD.[13]

Flowability

Flowability tests were conducted for the polyherbal powdered facial mask and the marketed mask in powder form. Two tests were conducted to determine four indicators of flowability (angle of repose, bulk density, Hausner's ratio, and Carr's index).

For the first test, a filter funnel was held over a piece of graph paper so that the distance between the graph paper and the end of the filter funnel was 17 cm. Next, 50 g of the mask was placed in the funnel and released simultaneously to allow a free flow of the powder onto the sheet. The height of the pile (h) and the diameter of the base of the pile (d) were measured and recorded. The radius of the base of the pile (r) was obtained by dividing the diameter of the base by two. The angle of repose was calculated by using Equation 1. Flowability test was replicated for three times to obtain the average angle of repose (°) ± SD.

$$Angle\ of\ repose\ (\theta) = tan^{-1}\frac{h}{r} \qquad (1)$$

For the second test, 100 g of the mask was placed in a graduated measuring cylinder. The initial volume occupied by the powder (Vb) was measured. The powder was then tapped by jerking it at a height of approximately 5 cm for 100 consecutive repetitions. The volume occupied after tapping (Vt) was measured and recorded. The test was repeated for three times. Bulk density (Db), Hausner's index (H), and Carr's ratio (C) were calculated using Equation 2, Equation 3, and Equation 4, respectively.

$$Bulk\ density\ (Db) = \frac{M}{Vb} \qquad (2)$$

$$\text{Hausner's index (H)} = \frac{100}{100-C} \qquad (3)$$

$$\text{Carr's ratio(C)} = \frac{Vb-Vt}{Vb} \qquad (4)$$

where M represents the mass of powder. Carr's ratio represents the compressibility of a powder. The greater the difference between the initial volume and the compacted volume, the greater the C. Hausner ratio, a ratio between the tapped density and the aerated density, is used to assess the flowability of a powder.

Loss on drying

A total of 3 g polyherbal powdered mask and marketed mask in powder form was weighed and placed in ceramic dishes. Then, it was subjected to 100°C for 24 hours in an oven. At the end of the drying process, the sample was weighed again. The differences in weight before and after drying were calculated. Loss on drying test was replicated for three times to obtain the mean percentage loss (%) ± SD.

Heavy metal determination

Atomic absorption spectrophotometry (AAS) was used to detect the presence of heavy metals in the polyherbal powdered facial mask. Serial concentration of lead and cadmium standards was prepared using ultrapure water. Various concentrations of the standards were subjected to AAS. Calibration curves for lead and cadmium standards were generated by plotting the absorbance against the concentration of the standards. Then, the polyherbal powdered facial mask was solubilised in ultrapure water with a few drops of hydrochloric acid before being subjected to AAS. The concentration of heavy metals was calculated by using the equation obtained from the calibration curve.

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging test

DPPH radical scavenging test was performed using the method previously described by Mogana et al.[18] The stock solution of the tested samples was prepared in a suitable solvent, ethanol. Different concentrations of the test samples were added to the 96-well plate in decreasing order. Next, 100 µL of 0.1 mM DPPH solution was added to the test samples, while 100 µL of methanol was added to the test samples as a control. The plate was covered with aluminium foil to protect it from light, gently shaken for 2 minutes, and then incubated in the dark for 30 minutes. The percentage of discolouration was determined spectrophotometrically at 550 nm using a microplate reader.

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The percentage of discolouration was plotted against the concentration of the samples tested. Prism 9 software was used to determine the half maximal inhibitory concentration (IC_{50}) of the samples tested. DPPH radical scavenging activity increased with decreasing DPPH absorbance. The antioxidant capacity was calculated according to Equation 5.

$$DPPH\ Inhibition\ (\%) = \frac{Control\ Abs - Sample\ Abs}{Control\ Abs} \times 100 \qquad (5)$$

where Control Abs is the absorbance of the DPPH radical without test samples.

Statistical analysis

All data were recorded, edited, and entered using IBM SPSS Statistics Version 20 (Chicago, IL, USA). The data obtained were expressed in average ± standard deviation (SD). The significant difference between groups was analysed using the one-way analysis of variance (ANOVA) followed by Tukey's honest significance test (HSD) test or independent samples t-test (for parametric data) where applicable. Kruskal-Wallis test (for non-parametric data) was performed to identify significant differences between groups. p-value < 0.05 was considered statistically significant.

Results and Discussion

Formulation of polyherbal powdered facial mask

The base of the polyherbal powdered facial mask was chickpea flour, which is rich in polysaccharides. When water is added to the polyherbal powdered facial mask, it swells and forms a viscous paste. The flour proteins also act as emulsifiers in the formula. Curcumin is responsible for the mask's colour, while turmeric terpenes give the mask a spicy scent. Tomato powder has antioxidant, anti-ageing, and photoprotective properties. Although some of the coloured compounds and antioxidants are photosensitive, the mask is intended to be applied in the evening with a ten-minute break time, which will not alter its properties. Distilled water was gradually added to the polyherbal powdered facial mask to determine the ideal amount of water required to obtain a homogeneous paste for application. In conclusion, the water/powder ratio of 1.25: 1 was ideal for the topical application of the polyherbal mask.

Organoleptic characteristics

According to Table 1, the polyherbal powdered facial mask and the marketed mask (Lemasque Orange Peel Off Rubber Mask) did not have the same colour, smell, or texture. Additionally, they fall under different categories of masks: polyherbal mask is a rinse-off mask, while the marketed mask is a peel-off mask. This distinction explains the differences in texture.

The odour and colour of the polyherbal powdered facial mask appeared to be the characteristic odour and colour of turmeric and tomato powder. The powder was rough before application but became smooth and easily applied in paste form. However, the observations were recorded based on the researcher's opinions and preferences. These sensory attributes are important as they will affect consumers' purchasing behaviour. Thus, a hedonic test may be conducted in the future to identify the best formulation that is preferred by at least 60 consumers.

Particle size determination

Table 2 shows the particle size of the ingredients. Particle size of the ingredients was compared with the nominal size of the aperture of various sieve numbers to classify the coarseness of the powder.[17] Generally, the size of the holes in the sieve must be larger than the powder to allow it to flow through. According to the sieve method, chickpea flour passed through sieve number 355 (moderately fine), while turmeric powder and tomato powder passed through sieve number 500 (moderately coarse) and sieve number 710 (coarse), respectively. In contrast, the marketed powdered mask (Lemasque Orange Peel Off Rubber Mask) passed through sieve number 125 sieve (very fine).

The ingredient with the largest particle size was tomato powder due to the preparation of tomato powder in the lab without using more advanced equipment. After freeze-drying, the tomato powder was grinded using only a mortar and pestle, whereas the turmeric powder and chickpea flour were processed by the manufacturer. Additionally, the particle size of the tomato powder may have been underestimated as some were too large to be measured using the sieve method.

A powdered facial mask is made of loose powder, which might be suspended in the air and pose a risk of inhalation. Larger particles are preferred to minimise inhalation exposure, promote elimination via the respiratory tract, and minimize deposition of particles in the lungs. Particles smaller than 10 µm in diameter can reach the alveolar region of the lung. Meanwhile, particles between 10 and 30 µm can be deposited in the tracheobronchial region, where the mucociliary escalator favours elimination by swallowing.[19,20] However, particles larger than 30 µm are trapped in the nasopharyngeal region and lost by sneezing or blowing of the nose.[21] In the present study, the particle size of the polyherbal powdered facial mask was much larger than 30 µm, which means that they will be trapped in the nasopharyngeal region and expelled by sneezing or blowing of the nose.[19] Hence, the polyherbal powdered facial mask does not pose a risk of inhalation.

pH determination

pH test showed that the most basic ingredient was chickpea flour, followed by turmeric powder and tomato powder, as shown in Table 3. The acidic nature of the tomato powder is attributed to the presence of citric acid/citrate (pH = 1.7). Additionally, folic acid/folate (pH 4 - 4.8) and malic acid/malate present in chickpea flour contribute to the slightly acidic nature of chickpea flour. The higher pH of the chickpea flour may be due to the presence of carbohydrates such as starch, although it was not reported elsewhere. Independent samples t-test demonstrated that the average pH of the polyherbal powdered facial mask was significantly lower than the marketed powdered mask (Lemasque Orange Peel Off Rubber Mask). However, the average pH of the polyherbal powdered facial mask was within the optimal pH (pH 4.7 to 5.7) for facial and body skin.[22] The skin acts as a barrier to the external environment, and a change in pH can affect its function. Therefore, a cosmetics product must have a pH close to the facial skin, i.e., between pH 4.7 and 5.7. Basic pH generally favours the proliferation of microorganisms. For example, acidic pH favours the formation of blastospores in *Candida albicans*, but an increase in pH favours the mycelial (pathogenic) phase of *C. albicans*. Besides, acne-causing *Propionibacterium acnes* thrives at a pH between 6 and 6.5. Since alkaline products encourage its development, a slightly acidic pH is preferable to inhibit its growth. Furthermore, bacterial growth and survival are impossible at a pH below 4.5. Bacterial growth affects the stability of the products and may affect their shelf life. Strict control of microbial count and the presence of harmful microbes is vital to ensure product safety.[23]

Spreadability

The ease of spread of the mask affects the consumer's overall satisfaction with the product. The spreadability of the marketed mask (Lemasque Orange Peel Off Rubber Mask) at 100 g was significantly better than the polyherbal powdered facial mask, as shown in Table 4. This indicates that the marketed mask spreads better than the polyherbal powdered facial mask when a little force is applied. Although a cosmetic facial mask should be easily spread, it should not run down the face when applied. Thus, it should not be too watery. Hence, the spreadability of the polyherbal facial mask is ideal for application. In contrast, the marketed mask spreads easily at the beginning due to its relatively watery nature. After that, it gels up due to the presence of thickener, i.e., alginate. A peel off mask containing soybean extract was formulated with moisturising and skin-brightening effects.[24] Another peel off mask containing virgin coconut oil was developed with an antibacterial activity.[25] However, no other studies have been conducted using polyherbal powdered facial masks. Hence, the present study provides future direction for researchers to venture into the potential of polyherbal powdered facial masks.

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Table 1: Organoleptic characteristics of the masks

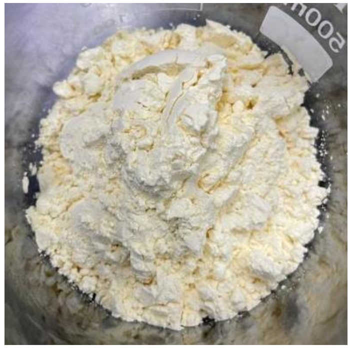
Organoleptic Characteristics	Polyherbal Powdered Facial Mask		Lemasque Orange Peel Off Rubber Mask	
	Powder	**Paste (water/powder ratio: 1.25/ 1)**	**Powder**	**Paste (water/powder ratio: 1.25/ 1)**
Illustration				
Colour	Saffron yellow (RAL 1017)	Yellow-orange (RAL 2000)	Wax yellow (RAL 090 90 30)	Luminescent yellow (RAL 095 90 50)
Texture	Fairly homogeneous with a large particle size that poses a risk of mechanical exfoliation.	Homogeneous, easy to spread with a soft texture.	A fine powder that tends to form lumps.	Watery and homogeneous, with a few small lumps remaining.
Application	-	Easily removed by rinsing with water.	-	Formation of a peel off film.

Table 2: Particle size of the ingredients

Ingredients	Average Particle Size (μm) ± SD	*p*-value
Chickpea Flour	290.73 ± 90.22	-
Turmeric Powder	487.03 ± 201.63	-
Tomato Powder	591.16 ± 397.89	-
Polyherbal Powdered Facial Mask	412.71 ± 271.40	< 0.01*
Lemasque Orange Peel Off Rubber Mask	100.99 ± 48.15	-

* Kruskal-Wallis test was used to detect significant differences between polyherbal powdered facial mask and Lemasque Orange Peel off Rubber Mask, where *p*-values < 0.05 were considered significant.

Table 3: pH of the ingredients

Ingredients	Average pH ± SD	*p*-value
Chickpea Flour	6.19 ± 0.33	-
Turmeric Powder	5.89 ± 0.02	-
Tomato Powder	4.60 ± 0.02	-
Polyherbal Powdered Facial Mask	5.31 ± 0.13	< 0.01*
Lemasque Orange Peel Off Rubber Mask	6.75 ± 0.05	-

* Independent samples t-test was used to detect significant differences between polyherbal powdered facial mask and Lemasque Orange Peel Off Rubber Mask, where *p*-values < 0.05 were considered significant.

Flowability

Angle of repose indicates how well a powder flows. The average angle of repose for the polyherbal powdered facial mask was 35.47°, as shown in Table 5. Thus, its flowability falls between good free flow and acceptable flow. In contrast, the marketed mask (Lemasque Orange Peel Off Rubber Mask) had an average angle of repose of 45.9°, corresponding to a fairly free flow. The powder gets stuck in the carbon funnel orifice, causing the particles to agglomerate. The angle of repose of the polyherbal powdered facial mask was significantly lower than the marketed mask, which implies that the polyherbal powdered facial mask flows significantly better than the marketed mask. Bulk density is the mass of the powder in a given volume, including the permeable and impermeable voids in the particles and the voids between the particles. The bulk density of the polyherbal powdered facial mask was 0.36 g/cm^3, whereas the bulk density of the marketed mask was 0.45 g/cm^3. The polyherbal mask had a significantly lower bulk density than the marketed mask. Hence, the polyherbal mask was lighter as compared to the same volume of the marketed mask.

Hausner's ratio explains the ability of particles to flow freely, evenly, and constantly. Meanwhile, Carr's index describes the compressibility of the powder, i.e., its ability to retain its volume when subjected to external forces. The polyherbal powdered facial mask had a good compressibility with Carr's index of 25%, whereas the marketed mask had a poor compressibility with Carr's index of 29%. The difference in their compressibility can be explained by the larger particle size of the polyherbal masks, which results in greater porosity. Besides, the particle size of the marketed mask was more uniform than the polyherbal mask due to the relatively small value of standard deviation (48.15 vs. 271.40). As a result, the arrangement of the particles in the marketed mask is different from the polyherbal powdered facial mask and perhaps more uniform with less porosity. The Hausner ratio for both masks was close to 1.00, indicating that the powders' flowability is excellent. However, Hausner's ratio and Carr's index of both masks were not significantly different.

Loss on drying

Loss on drying indicates the loss of volatile matter at the given temperature (100°C). Since water boils and vaporises at 100°C, it is estimated that the loss of mass on drying is equal to the mass of water vaporised. The percentage loss on drying of the masks is shown in Table 6. The marketed mask (Lemasque Orange Peel off Rubber Mask) had a significantly lower percentage loss on drying than the polyherbal powdered facial mask. However, the percentage loss on drying for the polyherbal mask was less than 1%, which is low enough to preserve powdered cosmetics products. Ajazuddin et al. demonstrated that powdered drugs with 8.25 ± 0.582% water were acceptable.[26]

Besides, the European Patent Fascicle highlighted that powdered cosmetic innovations with a relative humidity between 2% and 4% were ideal. The water content of the polyherbal mask was lower than 2%, which was acceptable and less prone to microbial contamination. The presence of water in a cosmetics formulation poses a risk of microbial contamination, which subsequently causes skin infections, rashes, and irritation. Water activity (aw) of ingredients affects the rate of proliferation of microorganisms in the formulation. For instance, the lower the aw, the lesser the proliferation of microorganisms. According to literatures, the water activity of the polyherbal mask was estimated to be high due to the high water activity of fruits (tomatoes) and legumes (chickpeas). Water activity above 0.60 favours the growth of microorganisms. Thus, adding natural water activity depressants such as very fine powdered sucrose is crucial to bind to the available water and limit microbial growth.

Heavy metal determination

Both lead and cadmium were not detected in the polyherbal powdered facial mask. Thus, the polyherbal mask is safe for use. Heavy metals are metalloids found in the environment. They can be found in trace amounts in many cosmetic ingredients and pose a health risk to consumers. Arsenic, lead, cadmium, mercury, chromium, and copper are some examples of heavy metals. Cadmium is carcinogenic, mutagenic, and toxic to the reproductive system. Lead causes various disorders such as digestive problems, high blood pressure, decline in kidney function, reproductive problems, and extremely high blood lead levels can lead to death. Moreover, mercury is toxic to the nervous, digestive, and immune systems, as well as the lungs, kidneys, skin, and eyes.[27]

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging test

Skin ageing occurs when it is subjected to oxidative stress. Antioxidants work by inhibiting free radical-mediated cellular degradation pathways, eliminating oxidative stress, and stimulating DNA repair.[28] Half maximal inhibitory concentration (IC_{50}) indicates the concentration at which 50% of the DPPH is inhibited. The lower the IC_{50}, the stronger the antioxidant activity of the ingredient. According to Table 7, the polyherbal powdered facial mask and the individual ingredients had a higher IC_{50} than ascorbic acid.

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Table 4: Spreadability of the ingredients

Ingredients	Average Spreadability (cm) ± SD			
	100 g	***p*-value**	**200 g**	***p*-value**
Polyherbal Powdered Facial Mask	3.93 ± 0.05	0.018*	4.37 ± 0.17	0.109
Lemasque Orange Peel off Rubber Mask	4.87 ± 0.42	-	5.07 ± 0.55	-

* Independent samples t-test was used to detect significant differences between the polyherbal powdered facial mask and Lemasque Orange Peel Off Rubber Mask, where *p*-values < 0.05 were considered significant.

Table 5: Flowability of the ingredients

Ingredients	Flowability ± SD			
	Angle of Repose, º	**Bulk Density, g/cm³**	**Hausner's Ratio**	**Carr's Index, %**
Polyherbal Powdered Facial Mask	35.47 ± 1.90*	0.36 ± 0.03*	1.00 ± 0.0001	0.25 ± 0.01
Lemasque Orange Peel Off Rubber Mask	45.93 ± 1.65	0.45 ± 0.02	1.00 ± 0.0004	0.29 ± 0.04

* Independent samples t-test was used to detect significant differences between polyherbal powdered facial mask and Lemasque Orange Peel Off Rubber Mask, where *p*-values < 0.05 were considered significant.

Among these, the IC_{50} of the polyherbal mask and chickpea flour was significantly higher than that of ascorbic acid. Consequently, the antioxidant capacities of the polyherbal mask and chickpea flour were significantly lower than the positive control.
Phenolic compounds such as curcuminoids and flavonoids present in turmeric contribute to its antioxidant activity.[10] Among the curcuminoids, curcumin has a significant antioxidant activity. The relatively weak antioxidant effect of the polyherbal mask may be due to the weak antioxidant effects of tomato powder and chickpea flour. Thus, the antioxidant effect of the polyherbal mask was mainly attributed to the 2.3% turmeric powder in the formulation. The limitations of the present study include the limited information (origin, storage conditions, and level of ripeness) of various ingredients. Additionally, the methods of harvesting and processing chickpea and turmeric are unknown. All these factors influence the antioxidant activity of the ingredients. Thus, reproducibility is impossible without standardisation of the ingredients.

Table 6: Percentage loss on drying of the masks

Ingredients	Percentage Loss on Drying (%) ± SD	*p*-value
Polyherbal Powdered Facial Mask	0.90 ± 0.08	0.002*
Lemasque Orange Peel Off Rubber Mask	0.57 ± 0.02	-

* Independent samples t-test was used to detect significant differences between polyherbal powdered facial mask and Lemasque Orange Peel Off Rubber Mask, where *p*-values < 0.05 were considered significant.

Table 7: IC_{50} of the ingredients

Ingredients	IC_{50} ± SD	*p*-value
Chickpea Flour	16.31 ± 2.18 mg/mL	<0.01*
Turmeric Powder	124 ± 14.08 µg/mL	1.000
Tomato Powder	2.36 ± 0.24 mg/mL	0.095
Polyherbal Powdered Facial Mask	4.40 ± 0.49 mg/mL	0.002*
Ascorbic Acid	2.72 ± 0.60 µg/mL	-

* One-way ANOVA test was used to detect significant differences between the ingredients and ascorbic acid (positive control), where *p*-values < 0.05 were considered significant.

Conclusion

A polyherbal mask was formulated using 2.3% *Curcuma longa* L. (turmeric) powder, 58.6% *Cicer arietinum* (chickpea) flour, and 39.1% *Solanum lycopersicum* (tomato) powder. The polyherbal powdered facial mask was formulated without synthetic ingredients such as SLS, sulphides, parabens, and alcohols that may cause skin allergies and irritation. Turmeric powder, chickpea flour and tomato powder work synergistically to combat skin ageing due to their anti-inflammatory, antioxidant and photoprotective effects. The polyherbal mask falls within the skin's physiological pH range; thus, it was skin-friendly. Additionally, the polyherbal mask was cosmetically acceptable due to its pleasant flow and spread for topical application. It was also safe for use due to the absence of heavy metals. In conclusion, polyherbal facial masks can be used as a safe and effective alternative to synthetic facial masks due to their antioxidant activity and acceptable cosmetics attributes.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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