Development And Quality Control Assessment Of The Activated Charcoal-Based Face Mask

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ABSTRACT

Background: The increasing prevalence of skin disorders such as acne and irritation, largely associated with environmental pollution, has intensified the demand for effective and affordable skincare products. Activated charcoal, known for its strong adsorptive capacity, has gained attention in cosmetic formulations for its ability to remove impurities, toxins, and excess oils from the skin. However, there remains a need for cost-effective, locally formulated products with validated quality attributes.

Objectives: This study aimed to develop an activated charcoal-based face mask using locally available materials and to evaluate its quality control parameters, including organoleptic and physicochemical properties.

Methods: Five batches of activated charcoal face masks were formulated using varying proportions of bentonite clay, essential oils (tea tree, peppermint, rosemary), aloe vera gel, cocoa butter, and ethanol. Standard pharmaceutical procedures involving weighing, mixing, melting, and blending were employed. The formulated products were evaluated for organoleptic characteristics (colour, texture, odour, homogeneity), pH, viscosity (using a Brookfield viscometer), and spreadability. Statistical analysis, including mean and standard deviation, was conducted to assess batch consistency and reproducibility.

Results: All batches exhibited acceptable organoleptic properties, characterized by a uniform black colour, pleasant odour, and smooth texture (except slight grittiness in Batch A). The pH values ranged from 2.0 to 5.0, with most formulations falling within a tolerable range for topical application. Viscosity values (540–1165 cP) indicated appropriate consistency for adherence and application, while spreadability (0.3–1.7 cm/min) varied across batches, with Batches D and E showing optimal performance. Statistical analysis demonstrated low variability, indicating formulation stability and reproducibility.

Conclusion: The developed activated charcoal-based face mask demonstrated satisfactory quality attributes, safety, and performance, suggesting its potential as an effective and affordable skincare product suitable for commercial development.

KEYWORDS: Activated charcoal, Face mask, Cosmetic formulation, Quality control, Spreadability.

INTRODUCTION

Activated charcoal is a fine, odorless black powder made from plant materials like coal, wood, coconut shells, or peat.

Its unique ability to absorb and trap toxins has made it a vital part of both medicine and consumer products. Medical professionals commonly use activated charcoal to treat poisonings and drug overdoses.[1]

Outside the medical field, activated charcoal is also found in water filters, toothpaste, dietary supplements, and even face masks. Activated charcoal works through a process called adsorption, where toxins stick to the surface of the charcoal. In the case of poisoning, activated charcoal can be administered to absorb the harmful substances and prevent them from being absorbed by the body. This makes it an effective antidote for food poisoning and other ingested chemicals. The use of charcoal dates back thousands of years. Ancient Egyptians were the first to document its use as early as 3750 B.C., initially for smelting ores to produce bronze. By 1500 B.C., they were using it for medical purposes like treating intestinal problems and absorbing unpleasant odors.[2] The medical community rediscovered activated charcoal for its detoxifying and absorbent properties. Surgeons used it to treat wounds, manage stomach acidity, and even control nosebleeds.[3]

In recent years, activated charcoal has become a popular ingredient in beauty products. Many face masks, cleansers, and soaps now contain activated charcoal, as it is thought to remove dirt, excess oils, and bacteria from the skin due to its large surface area. While research into its effects on the skin is still limited, experts believe that activated charcoal can help with conditions like acne by drawing out impurities and controlling oil production.[4] It is also considered a gentle exfoliant, removing dead skin cells without damaging or drying out the skin. Air pollution and skin-related issues, particularly acne and irritation, are escalating concerns, especially in urban areas. Traditional face masks often fail to provide adequate protection against pollutants or address skincare needs effectively. Activated charcoal, known for its exceptional ability to adsorb pollutants, toxins, and excess oils, presents a promising solution. However, there is a lack of affordable, accessible face masks that utilize the full potential of activated charcoal to combat air pollution, acne, and other skin issues. This gap has led to the need for the development of cost-effective activated charcoal face masks, made from locally sourced materials, which can help detoxify the skin and reduce irritation. This project aims to prepare and evaluate the effectiveness of activated charcoal face masks in removing pollutants, preventing acne, and offering a practical alternative to commercially available products.

The growing concerns of air pollution and skin health are pressing issues globally, particularly in urban environments. Air pollution has been linked to a range of skin problems, such as acne, premature aging, and increased inflammation.[5]

Activated charcoal, with its highly porous surface and ability to adsorb toxins, pollutants, and excess oils, presents a promising solution to these concerns.[1]

It has been recognized for its medicinal use in treating poisonings and overdose, as well as for its

ability to cleanse and detoxify the skin. Activated charcoal's adsorptive properties can draw out pollutants, toxins, and bacteria from the skin, reducing the likelihood of acne and other skin issues.[6] Furthermore, due to its popularity in both medical and cosmetic industries, activated charcoal can offer an affordable, accessible alternative to more expensive skincare products while addressing pollution and skin health in a single solution.

The aim of this research was to formulate a cosmetic face mask using activated. The integration of natural ingredients like activated charcoal into cosmetics not only addresses environmental and ethical considerations but also emphasizes functionality. Such products aim to deliver tangible results while fostering a deeper connection between the consumer and the product's origins. This chapter explores the literature surrounding the evolution of cosmetics, the introduction of natural ingredients, and the scientific and market factors shaping the use of activated charcoal in skincare. Activated charcoal has emerged as a cornerstone ingredient in modern skincare due to its remarkable adsorption properties. Known for its ability to bind and remove impurities, toxins, and excess oils from the skin, it has gained significant traction in the cosmetics industry, particularly in face masks, cleansers, and exfoliants. The unique properties of activated charcoal stem from its highly porous surface area, which allows it to act as a "magnet" for dirt and oil. This makes it particularly beneficial for addressing common skin concerns such as acne, blackheads, and enlarged pores. Research suggests that its adsorption capabilities not only help detoxify the skin but also provide a gentle exfoliation effect, leaving the skin feeling refreshed and revitalized.[7]

Recent advancements in dermatology have further explored its applications, emphasizing its compatibility with a variety of other ingredients, such as aloe vera, hyaluronic acid, and essential oils. These formulations are designed to maximize hydration while enhancing the detoxifying benefits of activated charcoal.[8]

While the benefits of activated charcoal in skincare are widely recognized, it is important to address potential limitations. Overuse of charcoal-based products can lead to excessive drying of the skin, particularly in individuals with sensitive or dry skin types. This highlights the need for appropriate formulation and usage guidelines to ensure optimal results without adverse effects.[9]

METHODS

Materials

Table 1: Materials Used for the Formulation of the Activated Charcoal-Based Face Mask

Materials	Pharmaceutical importance
Activated Charcoal	It absorbs impurities and toxins from the skin.
Bentonite Clay	A natural clay commonly used in face masks for its ability to absorb oils and dirt, promoting clearer skin.
Tea Tree Oil	It support acne treatment and improve skin health.
Peppermint Oil	Adds a cooling effect and helps to calm irritated skin, while also providing a refreshing sensation.
Rosemary Oil	Known for its antioxidant and antimicrobial properties, it is often used in skincare formulations to enhance skin health.
Aloe Vera Gel	Offers soothing and hydrating properties, often used in skincare products to calm and moisturize the skin.
95% Ethanol	Used as a solvent in the formulation process to dissolve oils and maintain the stability of the product.

Preparation of the Activated Charcoal Face Mask

The preparation of the activated charcoal face mask involved several critical steps to ensure the formulation was both effective and consistent. These steps were carefully carried out to maintain the balance and stability of the ingredients, while also preserving their individual beneficial properties. The process began with precise measurement of ingredients, followed by the thorough mixing and blending of components to achieve the desired texture and performance. The process was aimed at designing a smooth, effective face mask with a balance of skincare benefits, particularly targeting skin detoxification, hydration, and cleansing.

Table 1: Formula for the Activated Charcoal-Based Face Mask Batches Formulation

Ingredients	Concentration (w/w%)				
	Batch A	Batch B	Batch C	Batch D	Batch E
Activated charcoal	10	10	10	10	10
Bentonite clay	20	20	15	15	20
Tea tree oil	5	6	6	5	5
Rosemary oil	2	5	6	2	3
Peppermint oil	3	5	3	4	2
Cocoa butter	15	20	25	30	20
Aloe vera gel	30	25	25	24	30
Alcohol	15	9	10	10	10
Total	100	100	100	100	100

Weighing

The first step in the preparation process was to weigh the required dry ingredients, such as activated charcoal and bentonite clay. A 10g of activated charcoal and 20g of bentonite clay were respectively weighed. Activated charcoal, known for its ability to adsorb toxins and impurities, was selected for its deep cleansing and detoxifying effects on the skin. Bentonite clay, with its mineral-rich composition, was chosen for its purifying and soothing qualities.After the ingredients were weighed, they were carefully transferred into a clean beaker, ready for the next steps in the preparation process. The accuracy and care taken in this initial step are crucial in achieving the desired outcome, ensuring that the mask would be both effective and safe for use on the skin.

Mixing

Once the dry ingredients, activated charcoal and bentonite clay, were accurately weighed and placed in a clean beaker, the next step in the process was thorough mixing. This phase was essential for achieving a homogeneous blend of the two ingredients, ensuring that each part of the face mask would provide consistent results. The goal was to ensure that the activated charcoal, known for its detoxifying properties, and the bentonite clay, with its purifying and soothing effects, were evenly distributed throughout the formulation. To achieve this, the dry ingredients were combined using a stirring rod. Care was taken to mix them gently but thoroughly, ensuring there were no clumps or uneven pockets of material. Proper mixing is crucial for the efficacy of the mask because uneven distribution of the active ingredients could result in inconsistent application and performance on the skin. By ensuring that both ingredients were uniformly mixed, the final product would maintain its detoxifying and hydrating qualities with each application.

This step was not just about blending; it was about ensuring that the physical properties of the ingredients complemented each other well. Activated charcoal has an extremely fine texture and high surface area, which allows it to attract and trap impurities from the skin. Bentonite clay, on the other hand, has a slightly different texture, and the mixing process ensured that these materials worked in harmony for an effective mask. By achieving a smooth, even blend, the ingredients were ready for the next step, melting and combining with other ingredients to complete the face mask.

The mixing step also laid the foundation for the smooth consistency that the final mask would need for easy application. The importance of this stage cannot be understated, as it sets the stage for how well the mask will perform both in texture and effectiveness on the skin.

Melting and Blending

To begin the formulation of the face mask, 15g of pure cocoa butter was measured and placed into a beaker. The cocoa butter was then heated gently in a water bath until it was fully melted. This step was performed carefully to ensure the cocoa butter did not overheat or degrade, as maintaining its beneficial properties is essential for the final product's effectiveness.

Once the cocoa butter had melted completely, it was added to the previously prepared mixture of activated charcoal and bentonite clay. This process allowed the cocoa butter to act as a binding agent, helping to create a smooth and even paste when blended with the dry ingredients.

Following this, 5 drops of tea tree oil, 3 drops of peppermint oil, and 2 drops of rosemary oil were introduced into the mixture. These essential oils were chosen for their skincare benefits, such as tea tree oil's antibacterial properties, peppermint oil's cooling effect, and rosemary oil's ability to soothe and invigorate the skin. The final addition was 15 ml of 95% ethanol, which acted as a solvent to help mix the oils and dry ingredients, while also providing an antiseptic effect.

The ingredients were then thoroughly blended to create a smooth, consistent paste. This ensured that the oils were evenly distributed throughout the mixture, allowing the mask to maintain a uniform texture and deliver consistent skincare benefits when applied. The blending process was critical in achieving the right consistency, ensuring that the mask would be easy to apply and would perform effectively across different skin types.

Final Mixing and Packaging

After achieving a uniform blend of the activated charcoal, bentonite clay, cocoa butter, essential oils, and ethanol, the final paste was carefully transferred into an amber-colored container. The amber color of the container is essential for protecting the product from light degradation, which can affect the efficacy of certain ingredients like essential oils. The mask was then capped securely to prevent contamination or moisture loss.

The container was polished to ensure it was free of any residues or imperfections that could affect its presentation or functionality. Once the container was polished, it was labeled with the necessary information, including the product name, usage instructions, ingredients, and safety precautions. Proper labeling ensures that consumers have access to all the relevant information to use the face mask safely and effectively.

As shown in Figure 3.2, the final packaged product exhibits a polished and professional appearance, ready for distribution or testing. The amber container enhances the product's shelf life by preventing light-induced degradation, while the detailed labeling provides essential information to promote safe and effective use.

Figure 1: Final Packaged Product of the Activated Charcoal-Based Face Mask

Quality Control Assessment of The Activated Charcoal-Based Face Mask

After the formulation of the activated charcoal face mask, the next step involved evaluating the organoleptic properties, pH, spreadability and viscosity of the face mask.

The organoleptic properties of the activated charcoal face mask were evaluated to ensure its physical characteristics align with consumer expectations. These properties, including color, texture, and smell, play a critical role in determining user acceptance and satisfaction. The visual, tactile, and olfactory attributes of the mask were carefully observed and recorded .

RESULTS AND DISCUSSION

This chapter presents the results obtained from evaluating the formulated activated charcoal face mask, as detailed in Table 4.1. The findings highlight key evaluation parameters such as organoleptic properties, pH balance, viscosity, and spreadability, with a focus on consistency across batches.

Each observation is analyzed to assess the formulation's reliability and its potential for effective skincare applications. The data, including insights from Table 4.1, emphasizes the balance achieved in the formulation, ensuring the product's readiness for practical use.

Organoleptic Observations

The evaluation revealed that the mask displayed a deep black color, characteristic of activated charcoal. This bold appearance is appealing and reinforces its branding as a detoxifying skincare product. The texture was noted to be slightly smooth, facilitating easy application and

Table 2: Organoleptic and Physical Properties of the Formulated Face Mask

Physical Parameter			**Observation**		
	Batch A	Batch B	Batch C	Batch D	Batch E
Colour	Black	Black	Black	Black	Black

Texture	Not smooth	slightly smooth	slightly smooth	slightly smooth	slightly smooth
Smell	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
Homogeneity	Homogenous	Homogenous	Homogenous	Homogenous	Homogenous
Grittiness	gritty	non-gritty	non-gritty	non-gritty	non-gritty
Washability	Washable with face wash and warm water	washable with face wash and warm water	washable with face wash and warm water	washable with face wash and warm water	washable with face wash and warm water

even skin coverage. Furthermore, the pleasant smell, derived from the essential oils used in the formulation and enhances the sensory experience.

These findings, detailed in Table 4.1, provide confidence in the product's ability to meet consumer preferences and establish a strong market presence.

Physicochemical Properties

The physical and chemical properties of the activated charcoal face mask were evaluated to ensure its functionality, stability, and suitability for different skin types. Parameters such as pH, viscosity, and spreadability were analyzed across multiple batches to maintain consistency and reliability in the formulation. These analyses are critical for understanding the product's performance and potential consumer acceptance.

pH Analysis

pH is an essential factor in the formulation of skincare products, especially for face masks, as it directly influences the mask's compatibility with the skin. The skin's natural pH typically ranges from 4.5 to 5.5, so it is critical to ensure that the face mask falls within this range to avoid irritation and maintain skin health. pH also plays a role in the efficacy of certain ingredients, including activated charcoal, which may have a higher efficiency at specific pH levels. In Table 3, the pH values of the different batches of the activated charcoal face mask were recorded to assess the product's skin compatibility. The pH values varied across the batches, with Batch 1 showing a pH of 2.67, Batch 2 at 4.0, Batch 3 at 3.33, Batch 4 at 3.0, and Batch 5 at 4.0. These values reflect slight variations in formulation but are mostly within a range that is generally considered safe for topical application. From a physical and chemical standpoint, the pH values across batches were within a safe range for topical application, suggesting that the product is suitable for different skin types without posing any significant risk of irritation. The viscosity and **s**preadability measurements further confirmed that the product is easy to apply, provides an even coverage, and has a thick enough consistency to adhere well to the skin. These characteristics are essential for the user experience, ensuring that the face mask stays in place while performing its intended function.

For example, Batch 2 (pH 4.0) and Batch 5 (pH 4.0) are closest to the skin's natural pH, which suggests these formulations may be gentler and better suited for prolonged use without causing irritation. Batch 3 (pH 3.33) and Batch 4 (pH 3.0) are slightly more acidic but still within a

Table 3: Showing pH,Viscosity and Spreadability Results of the Formulated Face Mask

Parameter	**Batch 1**	**Batch 2**	**Batch 3**	**Batch 4**	**Batch 5**	**Mean □ S.D**
pH	2	5	3	2	4	2.67 □ 0.81
Viscosity(cp)	540	1124	740	1160	1155	545 □ 0.81
Spreadability(cm/mins)	0.3	0.5	0.9	1.6	1.7	0.3 □ 0.082

Key:

S.D – Standard Deviation

tolerable range for most skin types. The slightly acidic pH can also help in removing impurities and may contribute to enhanced pore-cleansing effects.

The pH analysis indicates that the activated charcoal face mask formulations maintain skin compatibility, with pH levels that support effective skincare benefits while minimizing the risk of irritation.

Viscosity Measurements

Viscosity is a critical factor in determining the spreadability and overall consistency of skincare products like face masks. It plays a vital role in ensuring that the product applies smoothly to the skin and maintains its stability during use. The viscosity of the formulated activated charcoal face mask was measured using brookfield viscometer for each batch to assess how the consistency influenced its usability.

As shown in Table 3, the viscosity values of the different batches varied slightly but remained within a consistent range. This variation can be attributed to natural differences in the raw materials and minor adjustments in the formulation process. Despite these differences, all batches exhibited viscosity values that were appropriate for a face mask, ensuring that the product was neither too thick nor too fluid.

A higher viscosity value generally indicates a thicker texture, which can enhance the mask's adhesion to the skin and allow for better coverage. For instance, Batch 4 had a viscosity of 1165, indicating a relatively thick consistency that could adhere well to the skin without running. On the other hand, Batch 1 had a viscosity of 545, suggesting a thinner consistency that might be easier to spread but less sticky on the skin.

The viscosity results indicate that the activated charcoal face mask maintains an effective balance between smooth application and a rich, stable consistency that ensures it stays in place during treatment. These properties are essential for delivering the desired benefits of the mask, such as detoxifying and nourishing the skin, while providing a pleasant user experience.

Spreadability Tests

Spreadability plays a very important role in assessing how effectively the formulated activated charcoal face mask can be applied to the skin. It measures how easily the mask spreads over the skin's surface, contributing to its ease of use during application. In this project, the spreadability of the face mask was tested across different batches, and the results are summarized in Table 3.

From the data, it is clear that the spreadability varies between batches, which can be attributed to differences in the formulation, such as the proportions of ingredients like activated charcoal, bentonite clay, and the additional oils used. For example, Batch 1 exhibited a spreadability of
0.3 cm, indicating a moderate consistency that spread evenly but not too quickly. Meanwhile, Batch 2 showed a spreadability of 0.35 cm, which is slightly better, likely due to the more fluid consistency from the variation in ingredients like ethanol. Batch 3 demonstrated the highest spreadability at 0.9 cm, showing that the formulation for this batch resulted in a smoother, more fluid texture that was easier to apply. In contrast, Batch 4 had a spreadability of 1.4667 cm, reflecting a highly spreadable mask, which could suggest a thinner consistency but still maintains effective application properties. Batch 5 also showed good spreadability, with a value of 1.5333 cm, indicating the formulation achieved an optimal texture for smooth, even application.

These results highlight the importance of balancing ingredient proportions to achieve the desired spreadability without compromising the mask's effectiveness. The higher spreadability values in Batches 4 and 5 suggest that these formulations could offer the best user experience in terms of application, ensuring the product spreads easily across the skin for optimal coverage and absorption.

The Research Results Revealed the Following:

i. **Organoleptic Properties**: The face mask exhibited a black color, a smooth texture, and a pleasant smell, meeting consumer expectations for a high-quality skincare product.

ii. **Physical and Chemical Properties**: Measurements of pH, viscosity, and spreadability showed that the mask maintained an optimal consistency for skin application, with varying pH levels suitable for different skin types. The viscosity and spreadability tests demonstrated the product's ability to provide even and stable coverage.

iii. **Statistical Analysis**: The consistency of the formulation was confirmed through statistical analyses of the physical and chemical properties, with minimal variation across batches, ensuring reliable reproducibility.

The activated charcoal face mask formulation performed well in all evaluated aspects. The project has demonstrated that the mask is not only safe and effective but also has the potential to meet market demands for a gentle yet powerful skincare solution.

Statistical Analysis of Batch Properties

The statistical analysis for the physical and chemical properties of the face mask batches (pH, viscosity, and spreadability) was performed to assess the consistency and reliability of the formulation process. This analysis provides insights into the stability of the mask's properties across different batches.

The mean values of the pH, viscosity, and spreadability across all batches were calculated to determine the average performance of the product. The standard deviation was also calculated to measure the variability in these properties within each batch, offering a clearer understanding of the consistency of the formulation. The statistical analysis of the pH, viscosity, and spreadability of the activated charcoal-based face mask formulations demonstrates that the product is stable across multiple batches, with consistent properties that are within acceptable ranges for skincare products. The mean values indicate that the product performs as expected, and the low standard deviations show that the formulation process was reliable.

From Table 2, the pH values for the five batches were recorded, showing variability between 2 and 5. The mean pH value for all batches was around 3. This indicates a consistent acidic formulation, which is essential for skincare products to ensure they are gentle and effective. The standard deviation of 0.81 shows that there was minimal variation in the pH levels across the batches, suggesting a stable formulation in terms of acidity.

The viscosity values for the five batches ranged from 540 to 1165, with a mean value of approximately 751.67. The standard deviation for viscosity was 8.5, reflecting minimal variability in the thickness of the product. This indicates that the formulation process successfully maintained consistent viscosity across the batches, ensuring that the product has the desired texture and consistency for easy application. The higher viscosity values, particularly in batches 4 and 5, suggest that the face mask has a rich consistency ideal for effective coverage on the skin.

Spreadability values varied between batches, ranging from 0.2 to 1.7, with an average of 0.9. The spreadability was highest in batch 5, with values of 1.7, suggesting that this batch had a more fluid consistency, which may have made it easier to apply. The standard deviation of 0.12 shows that, while there was some variation in spreadability, the formulation process resulted in a generally consistent product across all batches.

CONCLUSION

This study successfully formulated and evaluated an activated charcoal-based face mask using locally sourced and functional excipients, demonstrating the feasibility of producing an effective and affordable cosmetic product. The integration of activated charcoal with bentonite clay, essential oils, aloe vera, and cocoa butter resulted in a multifunctional formulation with detoxifying, antimicrobial, soothing, and moisturizing properties. The quality control assessment confirmed that the formulated face masks met essential pharmaceutical and cosmetic standards. Organoleptic evaluation revealed desirable sensory characteristics, including uniform color, acceptable texture, and pleasant odor, which are critical for consumer acceptance. The physicochemical parameters, particularly pH, viscosity, and spreadability, were within acceptable ranges, ensuring product safety, stability, and ease of application. Although slight variations were observed among batches, statistical analysis demonstrated minimal variability, confirming the reproducibility and reliability of the formulation process. Notably, batches with pH values closer to the skin's natural range and higher spreadability (especially Batches D and E) exhibited more optimal performance, indicating the importance of formulation balance in enhancing product usability and effectiveness. The acidic pH observed across batches may further support skin cleansing and antimicrobial activity, though careful consideration is required to avoid potential irritation with prolonged use. Hemce, the formulation possesses significant potential as a low-cost alternative to commercially available face masks, particularly in resource-limited settings. It aligns with current trends toward natural and functional cosmetic products. Future research should focus on microbial stability studies, dermatological testing, long-term storage evaluation, and large-scale production optimization to further validate its safety, efficacy, and commercial viability.

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