

Extraction of Protein and Oil from Watermelon Seeds and Formulation of Capsule and Anti-Acne Cream

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Abstract

Watermelon (*Citrullus lanatus*) is a fruit that is widely enjoyed for its juicy and refreshing taste, particularly during summer season. Watermelon and its properties, including its nutritional value, health benefits, and potential use. Watermelon is a low-calorie fruit that is rich in nutrients, including vitamins A, C, and B6 as well as antioxidants and mineral such as potassium and magnesium. Watermelon seed is commonly considered a waste material after consumption of the juicy fruit. Watermelon seed contain high level of healthy unsaturated fatty acids, proteins, minerals, and vitamins. Watermelon seed oil is a type of oil that is extracted from the Soxhlet apparatus method. Watermelon seed oil is a versatile oil that can be used in many different applications, including cooking, cosmetics and pharmaceuticals. Oil content in the seeds is between 35 - 40 % and the unsaturated fatty acid content in oil is 78- 86% predominantly linoleic acid (45-73 %). Watermelon seed oil is effective for skin care as it is light, easily absorbable and has humectants properties. Watermelon seed oil also known as Otenga oil or Kalahari oil suitable for cosmeceutical applications. High acid value in oil will produce soap during trans esterification process. High acid value of Watermelon oil necessitated acid pretreatment of the oil before trans esterification. Free fatty acids (FFA) are produced by the hydrolysis of oils and fats. Watermelon seed oil is emerging as a promising ingredient in anti-acne creams due to its multifaceted benefits for skin health. Rich in linoleic acid, antioxidants, and essential fatty acids, watermelon seed oil offers a non-comedogenic solution for acne-prone skin. This research examines the potential of watermelon seed oil as a key component in anti-acne creams, highlighting its role in providing comprehensive skincare solutions. The extraction of proteins from watermelon seeds presents a promising avenue for developing therapeutic formulations with potential health benefits. This study focuses on formulating hard gelatin protein capsules from watermelon seed extracts and evaluating their feasibility as a delivery system for bioactive compounds, particularly those with anti-inflammatory properties. The process involves extraction, purification, formulation into capsules, and rigorous evaluation to ensure stability, efficacy, and safety. Key parameters such as protein content, capsule disintegration, and anti-inflammatory activity are assessed to determine the capsules' suitability for pharmaceutical or nutraceutical applications. The findings highlight the potential of watermelon seed proteins in combating inflammation and supporting overall health through innovative encapsulation technology.

Keywords: Watermelon seeds oil, Extraction and Application, Acne prone, Capsule, Antiinflammatoiy, Albumin protein

Introduction

Botanically, Watermelon is known as *Citrullus lanatus*, it is a tropical fruit which can be taxonomically classified as the gourd family native to Southern Africa (Kalahari Desert). Water melon is a monoecious fruit which is cultivated for its large and delicious juicy edibility, usually ripened in August, they are warm season (frost intolerant) stretching annual fruit with stems as long as 5 meters with tendrils at the node and shallow root system. They have a general broad and lobed Leaves. Flowers are large, yellow which occur at the nodes. Watermelon seeds are the most discarded oil seeds. The seeds have nutritional values that are often compared favourably as well as soybean, sunflower and ground nuts (Van derVossen et al., 2004; Fursa 1981; Maynard, 2001; Oyolu, 1977). The climatic condition of the tropical

environments are characterized majorly with high transpiration rate owing to insufficient rainfall, therefore inhabitants of this regions rapidly rejuvenate their adequate supplies of vitamins, minerals, fibres and water from water melon fruit because larger percentage of the fruit consist of water (over 90%) as shown in (Figure 1) (Gabriel et al., 2017) and are also recommended for the control of weight (de Conto et al., 2011). The absorption of the antioxidant-rich food and energy formulation of Nigerian diets has been fundamentally based on fruits and vegetables but inappropriately, only the fleshy pulp (Figure 1) of these fruit have gained edibility attention leaving the seed (Figure 2) and the rind undesirable. The nutritional contents of watermelon seeds are of immense quality; they are rich sources of proteins, vitamins B,



Figure 1. Water melon fruit showing the pulp and seed embedded.



Figure 2. Watermelon seed

minerals such as magnesium, potassium, phosphorus, sodium, iron, zinc, manganese, copper and lipid, carbohydrates, fibre and the likes. The fibre content of the fruits and vegetables has been investigated to have beneficial effects on blood cholesterol and they prevent large bowel diseases (Godwin et al., 2008). It also contains some phytochemicals including saponins, alkaloids, phenols, flavonoids and tannins (Braide, 2012). (wt)[1,2,3]

The edible fruit of watermelon (*Citrullus lanatus*) belongs to the family Cucurbitaceae. The fruit contains many obovate, smooth compressed seeds thickened at the margin and of a black or yellowish white colour. Watermelon plays a very important role in Africa as it is used to quench thirst when there is shortage of water. The seed of watermelon (*Citrullus lanatus*) can be bruised and rubbed up with water to form an emulsion, which can be used to cure catarrhal infections, disorders of the bowels, urinary passage fever. In Nigeria, the watermelon seed is often discarded after the juicy part has been eaten. Watermelon has been cultivated in Africa and the middle east for thousands of years (at least 4000 in Egypt). It has been cultivated in China since at least 900 AD. Watermelon was brought to the new world in the 1500s. In the U.S. watermelon is a major vegetable crop that is grown primarily in the southern states. Watermelon has been improved by domestication and formal plant breeding from a late-maturing vine with small fruit. The fruit contains about 6% sugar and 90% water by weight and a lot of nutrients like carbohydrate, fat, protein, minerals like calcium, iron, magnesium, phosphorus, potassium, and zinc

and vitamins like vitamin B, C and notably vitamin A through its concentration of beta-carotene. It is also packed with some important natural and powerful antioxidants which travel through the body neutralizing free radicals which cause damage to human body Wolford. It is also being used as worm expeller. Seedless watermelons were initially developed in 1939 by Japanese scientists who were able to create seedless triploid hybrids which remained rare initially because they did not have sufficient disease resistance. Watermelons suffering from hollow heart are safe to consume. Watermelon has been improved by domestication and formal plant breeding from a late-maturing vine with small fruit having hard, white flesh and bland or bitter taste, into an early maturing, more compact plant with large fruit having edible, sweet flesh. In the last century, plant breeders working in public or private programs in the United States and around the world have released varieties having disease resistance, dwarf vines, larger fruit, higher sugar content, higher lycopene content, seedlessness, and new flesh colors, such as scarlet red, dark orange, and canary yellow. Recent advances in the breeding of seedless triploid hybrids have resulted in renewed popularity of watermelons, and per capita consumption has increased 37% since 1980. Watermelon's history dates back 5000 years to southern Africa where the tough, drought-tolerant ancestor of watermelon thrived. Although we don't know the exact identity of this plant, we do know it was prized for its ability to store water and was used by indigenous people in the Kalahari Desert region. Unlike today's watermelon, it had very bitter flesh. Speculation exists, in addition to taking advantage of its water content, people endemic to the region roasted and ate its seeds as a source of nourishment. Some tomb paintings depict an oval-shaped watermelon, indicating the round wild type must have been improved by ancient plant breeders. Quite likely, it was during this period of early improvement that progress was made in developing melons with sweeter, more palatable flesh. Thus, watermelon was slowly transformed from a source of water to an enjoyable food. The Greeks and Romans considered watermelon to have medicinal properties. Notable Greek physicians Hippocrates and Dioscorides praised its healing properties and used it as a diuretic as well as a treatment for children who suffered a heatstroke. The latter was accomplished by placing a wet, cool watermelon rind on their heads. Later, the Roman naturalist Pliny the Elder described watermelon as a cooling food in his first century publication, *Historia Naturalis*. [4,5]

Watermelon Seeds Have Tremendous Nutritional value

Watermelon seeds are one of the most nutrient-dense varieties of seeds. They are a rich source of proteins, vitamins, omega 3 and omega 6 fatty acids, magnesium, zinc, copper, potassium and more. These seeds are high in calories though, so you need to be mindful of your portions. One cup of roasted watermelon seeds contains roughly 600 calories. Watermelon seeds are also linked with stronger immunity and better health. Due to the presence of magnesium these seeds can also cure hypertension, which is directly related to the heart health. Consumption of the watermelon seeds daily in moderate quantity helps in boosting your heart health and maintaining your blood pressure. Watermelon seeds have a high content of minerals like copper, manganese and potassium. And these minerals together with other micronutrients help in making our bones healthier. The seeds are linked with strengthening our bones and also improving the bone density. Watermelon seeds are a powerhouse of nutrients like folate, iron, zinc, copper, magnesium, potassium. These seeds are considered to be highly nutritious, as they are also rich in amino acids, proteins and vitamin B complex. All these nutrients together help in boosting your body's metabolism. They contain certain healthy fats which are extremely important for the body. Watermelon seeds are a good source of healthy fatty acids like oleic acid, linoleum acid which is required for proper functioning of the body. They contain certain healthy fats which are extremely important for the body. Watermelon seeds are a good source of healthy fatty acids like oleic acid, linoleum acid which is required for proper functioning of the body. Watermelon seed oil is widely used as the main ingredient for cosmetic products that work wonders in treating acne and early signs of aging. These seeds have antioxidants that help in reversing early skin aging. Consumption of these seeds

can provide your skin with an inner glow. Add a few seeds in your daily diet to get visibly healthy skin. Also, due to the presence of fatty acids it prevents dryness and provides hydration to the damaged skin. The seeds are filled with proteins and iron that are known to improve the texture and quality of hair. It helps in strengthening your hair strands and also it promotes hair regrowth. As these are high in magnesium content it makes the hair healthy that in turn prevents hair fall and damage. Watermelon seeds can promote your heart health in many ways. Being a good source of monounsaturated and polyunsaturated fatty acids. Studies suggested that these good fats are useful in protecting against heart attack, stroke. This seed contains a high amount of magnesium, which keeps your heart healthy and regulates normal blood pressure. Watermelon seeds are packed with iron and minerals, which enhance immune functions. These seeds also contain vitamin B complex also helps in this regard. Try to include watermelon seeds, if you are having weak bones and conditions like osteoporosis. Eating watermelon seeds regularly can prevent bone disorders as they are rich in magnesium, copper, potassium. Watermelon seeds are a rich source of vitamin B which helps to keep your brain and nervous system healthy. It is also useful in mood disorders, dementia. watermelon seeds have a generous dose of Vitamin C, they are useful in the management of the symptoms of Asthma. Vitamin C is a powerful dietary antioxidant that can help reduce the effects of Asthma. Although suggestive studies exist about the effects of watermelon seeds on asthma, more research is needed. Nevertheless, watermelon seeds are safe to consume and should definitely be an option for people suffering from Asthma. Watermelon as well as its seeds contain an organic chemical compound known as Lycopene. Lycopene has been studied to have powerful anti-cancer properties. A 2015 study has revealed that Lycopene can be used to prevent the onset and/or development of prostate cancer to some extent. Watermelon seeds are best consumed roasted. You can easily roast watermelon seeds and sprinkle some salt over them to make for a savoury snack. This can be both a delicious as well as a healthy way to consume watermelon seeds on the go. Apart from this, there are more extravagant recipes that you can try at home using watermelon seeds.[6,7,8]

Extraction of oil from watermelon seed

The extraction and characteristics of oil from fruit seed have been carried out but little has been done on the physiochemical properties and fatty acid composition of the oil from watermelon seed. The chemical composition of the oil extract gives a qualitative identification of oils which reveals guide in its commercialization and utility. Iodine value gives and index of the drying and polymerizing properties of oil while flash points indicates a substantial removal of solvent from a solvent extracted oil. The characterization based on different fatty acids groups gives an insight into the distribution of acids in the unsaturated fraction among oleic, linoleic and linolenic acids. The aim of for the seed and assess the quality of the oil.[9,10]

1.3 Watermelon seed oil and its properties

It contains a multitude of nutrients that are incredibly beneficial for skin, health, and beauty, including linoleic and oleic acid, omega 3,6 and fatty acids, vitamin A, B and E, and a host of minerals, including magnesium, iron, copper, and potassium

Applications of Water Melon Seed Oil

1. Watermelon seed oil has excellent humectant and moisturizing properties.
2. It is to be observed that it has positive effect over the both oily and dry skin.
3. It is easily absorbed by the skin and helps in restoring the elasticity of the skin.
4. Watermelon oil can be utilized by cosmetic industries.

5. Preparation of moisturizer which shows properties similar to market grade moisturizer.
6. Antioxidants property of oil beneficial role in skincare in combating free-radicals resulting from sun damage and pollutants.
7. Seed oil formulated into skincare products in the form of emulsions and nano emulsions.
8. Seed oil should be more effective than peel wax as an additive in cosmeceutical products to reduce and prevent cellular damage.
9. Two forms of cosmeceutical products emulsions and nano emulsions were successfully formulated from watermelon seed oil extract.
10. Physicochemical properties of watermelon seed oil for their suitability in biodiesel production as raw materials to obtain biodiesel fuel.
11. As industrial ingredients in soap production, cosmetics and foam ingredient.
12. The high oil content of the watermelon seed coupled with a fairly high concentration of fatty acid make the seed suitable as food supplement.
13. Preparation of emulsions, soaps and detergents formulation.
14. Watermelon seed oil is good source of omega-6 fatty acids.
15. Watermelon seed has a great potential to use as an excellent source of edible protein.
16. Watermelon seed proteins shows various amino acids mainly Histidine and Glycine.[11,12]

MATERIALS AND METHODS

Collection of samples:

Collected the watermelon from the Chalisgaon fruit market. Then the watermelon seeds removed and dried in sunlight to remove moisture content. After that the crush the watermelon seed to powder form. Then powder was stuffed into filter paper. The powder sample of watermelon seed were kept in the Soxhlet apparatus for extraction.[13]

Oil Extraction:

The Soxhlet apparatus used for solvent extraction where 130ml of ethanol was poured into round bottom flask. 30 grams of powdered watermelon seed was placed in the thimble and inserted in the centre of the extractor. The Soxhlet was heated at 60°C. When the solvent was boiling, the vapor rises through the vertical tube into the condenser at the top. The liquid condensate drips into the filter paper thimble in the centre, which contains the oil to be extracted. The extract seeps through the pores of the thimble and fills the siphon tube, where it flows back down into the round bottom flask. This was allowed to continue for 30 minutes. It was then removed from the tube, dried in the oven, cooled in the desiccators and weighed again to determine the amount of oil extracted. The experiment was repeated by placing of the watermelon seed into the thimble. The weight of oil extracted was determined at 30 minutes interval. At the end of the extraction, the resulting mixture containing the oil was distilled off using simple distillation to recover solvent from the oil. The oil extracted sample was stored in a beaker container. For further uses of testing process.[14]

Collection of samples:

Watermelon was collected from fruits market in Coimbatore, then the seed was separated from watermelon fruit



Fig.3. Watermelon fruit

Watermelon seed dried in sunlight to remove moisture content



Fig.4. Dryseeds

Crush the watermelon seed to (until gets) powder form.

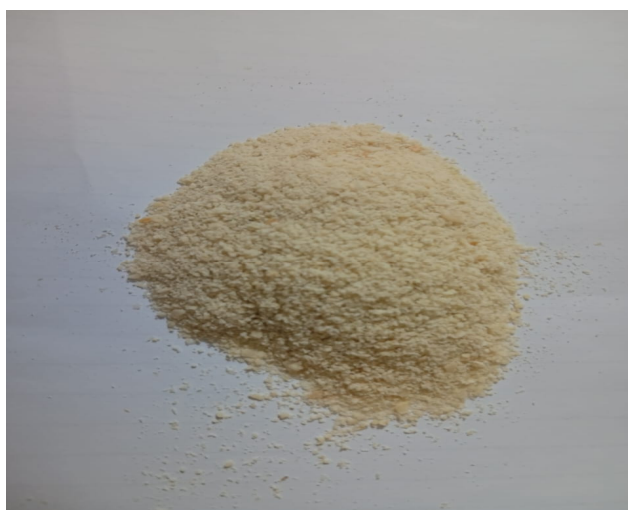


Fig.5. Powder form of watermelon seed

The powder sample of watermelon seed were kept in the Soxhlet apparatus for extraction process.



Fig.6. Soxhlet apparatus Soxhlet

Extraction process: The powdered seed material was solvent extraction using petroleum ether (n-hexane). The Soxhlet apparatus was used in the case. A total five times of 30g each of dried seed powder was in the filter paper. Then added the n-hexane (130ml) in Soxhlet apparatus. The oil content recovered from the sample container (50ml).[15]



Fig.7. Process of oil extraction



Fig.8. Watermelon seed oil extract

Formulation and Evaluation of Anti-acne cream containing watermelon seed extract oil

Pimple, acne, sunburn mark and pigmentation are issues that affected every individual at least once during life time. Consumers have begun to search for a product that can cure the skin issue and grant them with a good and healthy skin such as anti-acne cream. Nevertheless, most of the antiacne creams available in the market contain lots of chemicals that may have some kinds of side effects to the consumers. The present study was conducted to formulate and evaluate the anti-acne cream containing watermelon seed extract oil. Watermelon seed oil contains various chemical constituents that contribute to its potential anti-acne properties. While research specifically on watermelon seed oil for acne is limited, the following components may play a role:

1. **Linoleic acid:** Watermelon seed oil is rich in linoleic acid, an omega-6 fatty acid that has been shown to help regulate sebum production in the skin. Sebum is an oily substance produced by the skin's sebaceous glands, and excess sebum can contribute to acne formation. Linoleic acid helps to balance sebum production, potentially reducing the likelihood of clogged pores and acne breakouts.
2. **Oleic acid:** Although high levels of oleic acid are generally not recommended for acne-prone skin, watermelon seed oil contains a balanced ratio of oleic acid to linoleic acid. Oleic acid has moisturizing properties and can help maintain the skin barrier, which is important for preventing irritation and inflammation associated with acne.
3. **Antioxidants:** Watermelon seed oil contains antioxidants, including vitamin E, which can help protect the skin from oxidative stress and inflammation. Acne is often associated with inflammation, so antioxidants may help reduce inflammation and soothe acne-prone skin.
4. **Non-comedogenic properties:** Watermelon seed oil is lightweight and non-greasy, making it suitable for oily and acne-prone skin. It is easily absorbed by the skin without clogging pores, which is important for preventing the formation of acne lesions.

While watermelon seed oil may offer benefits for acne-prone skin due to its chemical constituents, individual responses to skincare products can vary. It's always a good idea to patch-test new products and consult with a dermatologist if you have specific concerns about acne or skincare.

Methods and preparation of anti acne cream

The composition of anti acne cream was shown in table No 1. The oil phase consists of white bees wax, and other oil soluble components such as watermealon seed oil and silicon oil were dissolved in the oil phase. The oil phase was placed inside the beaker in the water bath. The temperature of water bath was set to 75° c during the heating time. The water soluble components and preservatives(borax, methyl paraben) were dissolved in the aqueous phase and heated in the same water bath at temperature 75° c. After heating the aqueous phase was added in portion to the oil phase with continuous stirring.

[16,17,18]

Table No 1

Ingredients	Quantity (%W/W)
Oil Phase	
White Bees Wax	3.2
Watermealon seeds oil	5
Silicon oil	5
Rose oil	q.s

Aqueous Phase	
Borax	0.16
Methyl Paraben	0.02
Distilled water	6



Fig No 6 Formulated anti acne cream

Evaluation of Anti acne Cream

The following parameter were checked to evaluate the anti acne cream.

Homogeneity

The formulation was tested for homogeneity by visual appearance and touch.

Appearance

The appearance of the cream was judged by its color, pearlescence and roughness and graded.

After feel

Emolliency, slipperiness and amount of residue left after the application of fixed amount of cream were checked.

Type of smear

After application of cream, the type of film or smear on skin were checked.

Removal

The ease of remove of the cream applied were examined by washing the applied part with tap water.

Stability Test

The stability study was carried out by storing the anti acne cream at three different temperatures which are 8°C, 27°C and 40°C for 2 months.

PH : The pH meter was calibrated with the help of standard buffer solution. Weigh 0.5 gm of cream dissolved it in 50.0ml of distilled water and its pH was measured with the help of digital pH meter.

Extraction of protein from watermelon seeds

Watermelon seed protein is gaining attention due to its nutritional composition and potential health benefits. Rich in essential amino acids, watermelon seed protein is considered a high-quality protein source, suitable for vegetarian and vegan diets. Additionally, watermelon seed protein is gluten-free, making it suitable for individuals with gluten sensitivities or celiac disease. Incorporating watermelon seed protein into food products can enhance their nutritional profile and contribute to the growing demand for plant-based protein alternatives.

Watermelon seeds contain a variety of proteins, each with its own unique composition and function. While the specific proteins present in the extraction from watermelon seeds can vary depending on

factors such as seed variety, extraction method, and processing conditions, some common proteins found in watermelon seeds include:

1. **Albumin:** Albumins are water-soluble proteins that are typically found in seeds. They play various roles, including nutrient storage and transport.
2. **Globulin:** Globulins are another group of seed storage proteins that are soluble in salt solutions. They contribute to the nutritional value of seeds by providing essential amino acids.
3. **Glutelin:** Glutelins are seed storage proteins that are insoluble in water but can be solubilized in alkaline or acidic solutions. They play a role in seed development and germination.
4. **Prolamin:** Prolamins are a class of seed storage proteins characterized by their high content of proline and glutamine amino acids. They contribute to the nutritional quality of seeds and play a role in seed development.
5. **Enzymes:** Depending on the extraction method used, enzymes may also be present in the protein extract. Enzymes such as proteases may be used to break down cell walls and release proteins from the seed matrix during extraction.

Proteins extracted from watermelon seeds can exhibit various activities depending on their composition and properties. Some potential activities associated with watermelon seed proteins include:

Anti-inflammatory Activity: Proteins or peptides from watermelon seeds may have anti-inflammatory properties, reducing inflammation and associated symptoms. Anti-inflammatory activity can be evaluated using in vitro assays such as inhibition of inflammatory mediators or cell-based assays.

Antihypertensive Activity: Bioactive peptides derived from watermelon seed proteins may exhibit antihypertensive effects by inhibiting enzymes involved in blood pressure regulation, such as angiotensin-converting enzyme (ACE). ACE inhibition assays can be used to assess antihypertensive activity.

Procedure for the extraction of protein

1. **Collecting Seeds:** Gather fresh watermelon seeds and remove any pulp or debris from them.
2. **Drying:** Spread the seeds out in a single layer on a clean surface and allow them to air dry completely. This step helps remove excess moisture.
3. **Grinding:** Use a grinder or food processor to grind the dried seeds into a fine powder to ensure that the powder is uniform in texture.[19]
4. **Extraction:** Transfer the powdered seeds into a container and add a suitable solvent, such as water or an aqueous buffer solution, to the powder. Stir the mixture gently to allow the protein to dissolve into the solvent.[20]
5. **Separation:** After allowing the protein to dissolve fully, filter the mixture to separate the protein solution from any remaining solid particles or debris. You can use filter paper or a fine mesh sieve for this step.[21]
6. **Concentration:** If desired, concentrate the protein solution using methods such as evaporation or centrifugation to remove excess solvents and increase the protein concentration.
7. **Drying:** Finally, dry the extracted protein to obtain a powdered form that can be stored or used for further analysis.

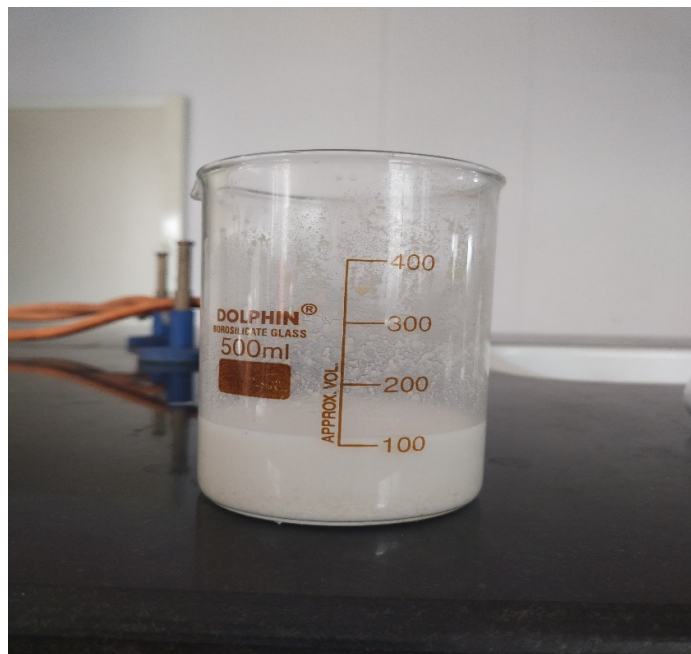


Fig No:7 powdered dissolve in water



Fig No:8 Extracted protein

Formulation and Evalution of protein capsule for antiinflammatory

Watermelon seeds are a nutritious and versatile food that offer a range of health benefits. They are an excellent source of plant-based protein, containing all the essential amino acids[22][23]. Watermelon seeds are also rich in healthy fats, fiber, vitamins, and minerals such as magnesium, potassium, iron, and zinc[22][23]. One of the key properties of watermelon seed protein is its anti-inflammatory effect. The seeds contain antioxidants and phytochemicals that help reduce inflammation in the body[24]. Additionally, the high magnesium content in watermelon seeds contributes to their anti-inflammatory properties[22]. Watermelon seeds have been traditionally used as a diuretic aid and for their potential benefits in managing conditions like diabetes, heart disease, and osteoporosis[22][25]. The protein and nutrients in watermelon seeds may also support hair growth, skin health, and immune function[22]. Watermelon seed protein capsules offer a convenient way to incorporate the nutritional and health-promoting properties of these versatile seeds into your diet. Their anti-inflammatory effects, along with their protein content and other beneficial nutrients, make watermelon seeds a valuable addition to a balanced and healthy lifestyle. Watermelon seeds have anti-inflammatory properties that can help reduce inflammation: - Watermelon seeds are rich in the amino acid L-citrulline, which has been shown to help

reduce muscle soreness and inflammation after exercise [26][27]. - The seeds also contain antioxidants like lycopene and vitamin C that can lower inflammation and oxidative damage over time[27]. A study found that watermelon seed extracts have anti-bacterial properties, suggesting they may have broader anti-inflammatory effects as well[5]. The high arginine content in watermelon seeds also provides medicinal benefits due to arginine's role in reducing inflammation [28]. Watermelon seeds are a good source of healthy fats, protein, and minerals like iron and zinc, all of which can contribute to an anti-inflammatory effect[27]. The unique nutrient profile of watermelon seeds, particularly their L-citrulline, antioxidant, and arginine content, gives them potent anti-inflammatory properties that may provide health benefits.

Watermelon seed protein capsules can be used as a dietary supplement to provide the following benefits:

- Promote heart health due to the presence of monounsaturated and polyunsaturated fatty acids, magnesium, and zinc which help protect against heart attack and stroke
- Regulate blood sugar levels and help manage type 2 diabetes due to the magnesium content which helps regulate carbohydrate metabolism
- Enhance immune function as watermelon seeds are packed with iron, minerals, and vitamin B complex
- Support bone health and prevent disorders like osteoporosis as they are rich in magnesium, copper, potassium, and other minerals

Improve brain and nervous system health due to the- vitamin B content- Boost energy levels for a longer period as watermelon seeds are rich in micronutrients.

- Provide a plant-based, gluten-free, Paleo-friendly protein source that is highly digestible, with 30g of protein per cup[28]

Materials and Methods

Albumin protein was obtained from the watermelon seeds. Empty hard gelatin capsules as sample form Ligo Capsules. Starch and methylcellulose and all other materials were obtained through commercial sources.

Formulation of Granules of albumin protein [29]

Formulation of Granules of Losartan Potassium [5]

Albumin protein granules were prepared by wet granulation method. Specified quantity of albumin, methyl cellulose and starch will be weighed and mixed uniformly. Required quantity of alcohol drop wise incorporated to the blend. Wet granules will be passed through sieve #40 and air dried for 15 minutes. The dried granules will then be passed through sieve #60. Required quantity of magnesium stearate & talc were added to the granules. The prepared granules were then added to the Size #3 empty hard gelatin capsule. The formulation of granules of losartan potassium is shown in Table 2

Table No:2 Formulation of granules of albumin protein

Sr.	Ingredients	Quantity(mg/gram)
1	Albumin protein	50mg
2	Methylcellulose	38mg
3	Starch	6mg
4	Magnesium stearate	4mg
5	Talc	2 mg
6	Alcohol	q.s



Fig No:9



Fig No: 10

Evaluation Parameter

Evaluation of micrometric properties of granules

1. Angle of Repose: The required amount of sample was allowed to drop down from the funnel mounted at the height of 6 cm, the height and radius of the heap was recorded for further calculations. Angle of repose (θ) can be calculated by using following formula: [31]

$$\text{Angle of repose } (\theta) = \tan^{-1}$$

Where, θ - Angle of repose

h - Height of the heap

r - Radius of the base

2.Bulk Density: It is calculated by the ratio of given mass of powder and its bulk volume. Determined by transferring 25 gm of accurately weighed amount of powder sample to the graduated cylinder. Bulk density = Mass/Volume[32]

3. Tapped density: It is measured by transferring a known quantity (10 gm) of powder sample into a graduated cylinder. The initial volume of sample in measuring cylinder was recorded and it was placed on tapped density determining apparatus to give subsequent tapping to the measuring cylinder containing sample continuously for a period of 10-15 min. Tapped density was determined as ratio of mass of powder and tapped volume which is calculated by following formula:[33]

$$\text{Tapped density} = \text{Mass} / \text{Tapped Volume}$$

4.Hausner's ratio

Hausner's ratio is an index of ease of powder flow; it is calculated by following formula:

$$\text{Hausner's ratio} = \rho_t / \rho_b$$

Where, ρ_t = Tapped density and ρ_b = Untapped bulk density[34]

5. Carr's Index

The simplest way of measurement of free flow property of powder is compressibility, an indication of the ease with which a material can be induced to flow is given by % compressibility which is calculated as follows:

$$C = (\rho_t - \rho_b) / \rho_t \times 100$$

Where, ρ_t = Tapped density and ρ_b = Untapped bulk density

6. Percentage yield

The percentage yield of the granules was determined for drug and was calculated using the following equation:

$$\text{Yield} = \frac{M}{M_0} \times 100$$

Where, M = weight of granules and M_0 = total expected weight of polymer

Result and Discussion

The dye test was confirmed that formulations were o/w type of emulsion cream. The pH of the formulated cream was found to be in range 4.6 to 4.8 which is good and recommended pH for the skin.

The formulated anti-acne cream was evaluated for several physicochemical tests and the results were shown in Table 2. The type of smear formed on the skin was not greasy after the application of both creams. The creams were easy to remove after application by washing with water. The formulations were able to produce uniform distribution of extracts in the cream. This was confirmed by visual examination and by touch. There were no changes in term of colour of the cream even it was kept for a long period of time. After feel test showed that the creams were emollient and slipperiness.

All the physicochemical parameters were maintained during the accelerated stability studies at temperatures $8^\circ\text{C} \pm 0.1^\circ\text{C}$ in refrigerator and at $25^\circ\text{C} \pm 1^\circ\text{C}$, 40°C , 1°C in incubator for 8 weeks. The results of accelerated stability test showed that there were no any changes in the colour of the cream.

Table No: 3 Physicochemical evaluation of the formulated anti- acne cream

Parameters	Result
Homogeneity	Good
Appearance	No change in colour
Odour	Good
Spreadability	Good
After feel	Emollient and slipperiness
Type of smear	Non- greasy
Removal	Easy
Irritation	No irritation

Table of No: 4Evaluation of Granules

Sr.No	Paramter	Obaervation
1	Tapped density	0.77g/ml
2	Bulk density	0.56ml
3	Angle of repose	35 ⁰
4	Carres index	7.5%
5	Hansion ratio	1.37

Conclusion

Solvent extraction is a traditional techniques of extracting vegetable oil. Oil seeds is one of the cheapest sources, applied to produce oil from seeds. Rate of extraction of oil from seed depends on type of solvent, partial size of watermelon seed, time of extraction and temperature. Soxhlet extraction is the most common technique for oil seed extraction. Watermelon seed oil is obtained from date seed through Soxhlet extraction technique. Oil content in the seeds is between 35-40% and the unsaturated fatty acid content in oil is 78-86% predominantly linoleic acid (45-73%). The ration of feed to solvent also important factor to be consider for extraction process which effect on the yield of oil. The extraction of date seed oil carried out 2-6 hrs. Ihe optimum time for extraction is 4 hrs. Crushed seed in powdered form gives large surface area for solid-liquid contact. Due to small size particles increase rate as well as yield of extraction of oil from watermelon seed. Extraction carried out at boiling temperature of solvent better for rate and yield of extraction.

Formulating and evaluating an anti-acne cream using watermelon seed oil involves harnessing its unique properties to effectively target acne-prone skin. watermelon seed oil into an anti-acne cream formulation, skincare products can leverage these benefits to effectively combat acne while promoting overall skin health. The formulation should be carefully evaluated for its efficacy in reducing acne symptoms, improving skin texture, and enhancing overall complexion. Regular use of such a cream can help individuals achieve clearer, smoother, and healthier-looking skin.

In conclusion, the formulation and evaluation of hard gelatin protein capsules from watermelon seeds extraction represent a promising strategy for developing natural anti-inflammatory agents. This review synthesizes current knowledge and highlights the potential of watermelon seed proteins in addressing inflammation-related disorders. Continued research and development in this area hold promise for advancing pharmaceutical and nutraceutical industries toward effective and sustainable therapeutic solutions. watermelon seed protein capsules can be a convenient way to supplement your diet with a nutritious, plant-based protein that provides a range of health benefits. However, it's always best to consult with a healthcare professional before starting any new supplement regimen.

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