Formulation and Characterization of *Stigma maydis*-Whey Protein Capsules in HPMC Shells for Obesity Management

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ABSTRACT

Corn silk (Stigma maydis) has a long history of use in traditional medicine for managing obesity[1][2]. Its bioactive phytochemicals include flavonoids and phenolic antioxidants, though their precise anti-obesity mechanisms are not fully elucidated[1][2]. Whey protein is a high-quality protein rich in essential amino acids (particularly sulfur-containing and branched-chain amino acids) that has been shown to promote fat loss and preserve lean muscle mass in obese individuals[4], as well as improve lipid and glucose metabolism[5]. In this study, we encapsulate powdered corn silk and whey protein together in plant-based hydroxypropyl methylcellulose (HPMC) capsules to enhance the stability and bioavailability of their combined bioactive. Capsules containing varying ratios of corn silk and whey protein were prepared and evaluated. By improving the stability and controlled release of the active components, this formulation is proposed as a novel nutraceutical functional food with potential synergistic anti-obesity effects[1][4][5].

Keywords:*Stigma maydis;* Whey protein; Plant-based capsule; HPMC; Obesity.

INTRODUCTION

The global obesity epidemic is a growing concern for public health[16]. Those who are obese or overweight and have associated medical concerns, the medical community provides a number of prescription obesity pills and drugs to help with weight management. These drugs reduce hunger, increase feelings of fullness, or prevent the absorption of fat, among other processes. The following list includes some of the obesity drugs that come in pill form: Orlistat (Alli, Xenical): About a third of the fat you eat is blocked from being absorbed by this medicine. It comes in a prescription strength (Xenical) in an over-the-counter, lower-dose form. It is taken with fatty meals [2]. Changes in bowel patterns may be among the

common digestive adverse effect. Whey Protein characteristics can vary based on multiple factors such as method of casein precipitation, storage conditions, heat treatment, and other variables [3]. As a capsule, it is taken once a day. It should not be taken by anyone who have hyperthyroidism, glaucoma, or who have taken certain MAOIs within the last 14 days. They may work together to control cravings and lessen hunger. People with uncontrolled hypertension, seizure problems, or eating disorders should not take it. These medications are typically prescribed for long-term use and are meant to be used in conjunction with a reduced calorie diet, increased physical activity, and behavioral changes. The decision to use medication should be made in consultation with a healthcare professional who can assess your individual health status, potential benefits, and risks associated with each drug. They will also monitor your progress and adjust treatment as needed. The encapsulation process was evaluated based on encapsulation efficiency, particle size, moisture content, antioxidant activity, and in vitro release profile.

One of these herbs is corn silk (*Stigma Maydis*). Corn silk (CS) is made from stigmas, the yellowish thread like strands from the female flower of maize. It is a waste material from corn cultivation and available in abundance. It has been consumed for a long time as a therapeutic remedy for various illnesses and is important as an alternative natural-based treatment [1]. It soothes and relaxes the lining of the bladder and urinary tubules, hence reducing irritation and increasing urine secretion [2].

Whey protein is a complete dietary protein derived from milk, containing high levels of essential amino acids (especially branched-chain amino acids) that stimulate muscle protein synthesis. Supplementation with whey protein has been demonstrated to increase fat loss and preserve lean mass during weight loss[4], and to improve insulin sensitivity and lipid profiles in overweight and obese adults[5]. Combining corn silk with whey protein may therefore offer complementary benefits: the herbal extracts provide antioxidant and diuretic effects, while the protein supports muscle health and metabolism.

Encapsulation technology can further enhance the efficacy of such a combination. Hydroxypropyl methylcellulose (HPMC) is a plant-derived polymer used to make vegetarian capsule shells. HPMC capsules have good physical stability and can modulate release of the capsule contents. In this work, we formulated HPMC capsules containing a powdered blend of corn silk and whey protein and 1 characterized their physicochemical properties. We hypothesize that these capsules will be stable and nutritionally enriched, serving as a potential plant-protein-based intervention for obesity management.

METHODOLOGY

Preparation of *Stigma Maydis*

The corn is harvested, collect the *Stigma maydis* from *Stigma maydis* and clean the corn silk. The *Stigma Maydis* is dried using hot air oven at 80^{o}c for 30 mins. The dried *Stigma Maydis* is milled and blended to ensure uniformity of *Stigma Maydis* Powder.

Preparation of Whey Protein

Whey is collected from Milk. Whey is processed to remove bacteria and lactic acid by thermal processing (pasteurization). Whey is concentrated by evaporating water to increase the solids content. Whey is blend into a powder using mixer or other methods.

Mixture of *Stigma maydis* Powder and Whey Protein

Multiple blend ratios (1:1, 2:1) were trialed to identify optimal encapsulation compatibility and functional benefits. The final ratio of this mixture *Stigma maydis* Powder and Whey Protein in Hydroxypropyl Methylcellulose is 2:1.

Capsule Filling

The mixed powder is filled into Hydroxypropyl Methylcellulose (plant-based capsules). Throughout the process, various quality control checks are performed like Ash content, Quality Control (Moisture content, Capsule Shell Integrity).

Fig 1

Whey

Fig 2

Whey Protein

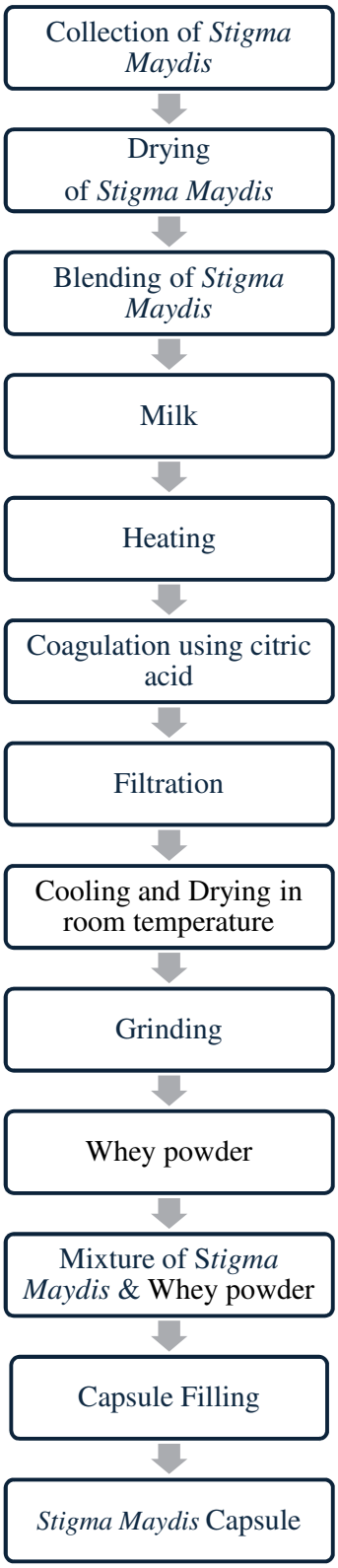
Fig 3

Stigma Maydis

Fig 4

***Stigma Maydis*Powder**

FLOWCHART


Collection of *Stigma Maydis*
Drying of *Stigma Maydis*
Blending of *Stigma Maydis*
Milk
Heating
Coagulation using citric acid
Filtration
Cooling and Drying in room temperature
Grinding
Whey powder
Mixture of S*tigma Maydis* & Whey powder
Capsule Filling
Stigma Maydis Capsule

DETERMINATION OF MOISTUER CONTENT

Weigh accurately about 5 g of the prepared sample in the moisture dish, previously dried in the oven at 105°C and weighed. Place the dish in the oven maintained at 105 ± 2°C for 4 hours. Cool in the desiccator and weigh. Repeat the process of drying, cooling and weighing at 30minute intervals until the difference between two consecutive weighing is less than one mg. Record the lowest mass.

Calculation

$$\text{MOISTURE, Percent by mass} = \frac{100(M1 - M2)}{M1 - M}$$

Where,

M1 = mass, in g. of the dish with the material before drying;
M2 = mass, in g, of the dish with the material after drying to constant mass;
M= mass, in g, of the empty dish.

TRAY DRYER:

In a tray dryer, many shallow trays are kept one above the other with a gap in between, in the drying chamber. Tray dryer is generally used for drying of vegetables and similar semi perishables. The trays may or may not have perforated bottom. Perforated trays are used when the plenum chamber is at the bottom of drying chamber. If the heated air is coming from the sides of drying chamber, the trays may not have perforated bottom. The gap in between the group of trays permits air ventilation. Products are kept in thin layers in the trays.

DETERMINATION OF TOTAL ASH

Weigh accurately about 5 g of the prepared sample in tared, clean and dry silica dish. Ignite the material in the dish with the flame. of a suitable burner for about one hour. Complete the by keeping in a muffle furnace at 500 plus/minus 10 deg * C until grey ash results. Cool in a desiccator and weigh. Repeat the process where of igniting, cooling and weighing at 1hour intervals until the difference between two successive weighing is less than 1 mg. Note the lowest mass. Preserve this ash for the determination of acid insoluble ash.

Calculation

$$\text{Total ash (on dry basis), Percent by mass} = \frac{(M_2 - M) \times 10000}{(M_1 - M)(100 - W)}$$

Where,

M_2 = mass, in g, of the dish with ash;
M = mass, in g. of the empty dish;
M_1 = mass, in g, of the dish with the material

CAPSULE SHELL INTEGRITY

Assessing the integrity of the *Stigma maydis*-whey protein capsules involves evaluating the physical condition and strength of the capsule shells to ensure they can withstand handling and storage without breaking, or leaking etc..

1. Visual Inspection:

This is the most basic and crucial first step. Capsules are visually examined for any physical defects such as cracks, breaks, dents, holes, or deformities. The seams where the cap and body join should be properly closed without any gaps.

$$\text{Integrity Rate (\%)} = \frac{\text{(Number of Intact Capsules)}}{\text{(Total Number of Capsules Inspected)}} \times 100$$

2. Leakage Test:

If the *Stigma maydis*-whey protein mixture has any liquid or semi-solid characteristics, a leakage test is essential. This usually involves visually inspecting capsules for any signs of leakage after being subjected to certain conditions (e.g., storage at specific temperatures and humidity levels, or gentle pressure).

3. Weight Variation Test:

While primarily for content uniformity, significant variations in the weight of empty capsule shells within a batch can indicate inconsistencies in the shell manufacturing process, potentially affecting their structural integrity. The formula for weight variation is:

$$\text{Weight Variation (\%)} = \frac{\text{(Individual Weight -Average Weight)}}{\text{Average Weight}} \times 100$$

RESULT AND DISCUSSION

The formulated capsules containing a mixture of *Stigma Maydis* and whey protein were evaluated for key physicochemical parameters. The plant-based capsule shells showed good

compatibility with the mixture and maintained their form even in slightly humid conditions. These results affirm the formulation's physical stability and suitability as an anti-obesity supplement with combined herbal and protein-based benefits.

The incorporation of whey protein into *Stigma Maydis* capsules enhances both the nutritional value and functional versatility of the supplement. While *Stigma Maydis* contributes bioactive flavonoids, antioxidants, and diuretic properties, whey protein adds high-quality amino acids that may support muscle health, metabolism, and immune function. Overall, this capsule formulation has potential as a natural nutraceutical supplement combining the therapeutic benefits of traditional herbs with the nutritional support of modern protein supplementation.

MOISTURE CONTENT	TOTAL ASH
5.6%	**4.5%**

Table 1

CAPSULE SHELL INTEGRITY

1. **Visual Inspection:**

   A high percentage of intact capsules (>95%) was observed, demonstrating good shell strength and manufacturing consistency.

2. **Leakage Test:**

   No leakage was detected, confirming proper encapsulation and stability of the capsule material.

3. **Weight Variation Test:**

   The variation was within the acceptable pharmacopeial limit of ±10%, indicating uniform filling of capsule contents.

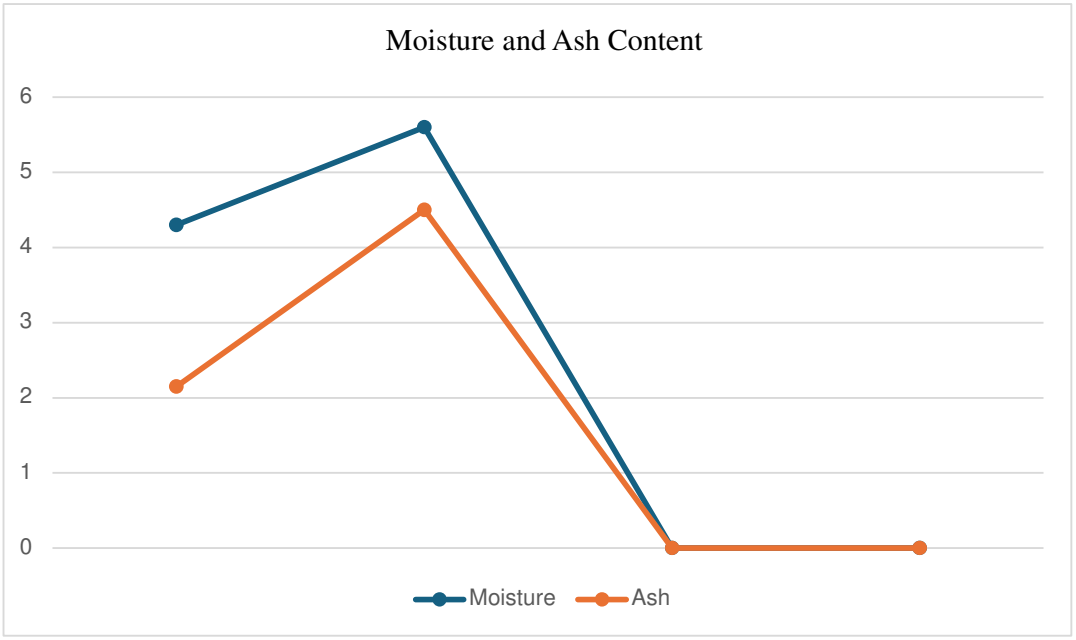


Fig 5 **Fig 6**

Hydroxypropyl methylcelluloseCapsule filling Powder (HPMC)

Fig 7

Filled Capsule

Fig 8

Obesity Capsule

CONCLUSION

The characterization of *Stigma Maydis* and whey protein capsules demonstrates that the formulation is physically stable, nutritionally enriched, and pharmaceutically acceptable for use as a natural supplement targeting obesity. The acceptable ash and moisture content, along with intact capsule shell integrity, indicate good shelf stability and safety. The combination of *Stigma Maydis*, known for its diuretic, antioxidant, and anti-inflammatory properties, with whey protein, a high-quality source of bioavailable amino acids, creates a synergistic effect that may support weight management by promoting satiety, improving metabolism, and reducing fat accumulation. Overall, these capsules show strong potential as a plant-proteinbased intervention for individuals seeking natural support in obesity prevention and management.

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