

Formulation and Evaluation of Verdant Tablets Containing Saponin-Coalesced Silver Nanoparticles Got from Fenugreek Seed Extract [†]

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Abstract: Presently, nanoparticles are in demand due to several applications. Commercially used metallic nanoparticles are usually comprised of synthetic chemicals. These chemicals are noxious and combustible. Current research had the objective to explore the advantages of nanoparticles using herbal material; hence, we developed silver nanoparticles of aqueous extract of *Trigonella foenum-graecum* (Fenugreek) seeds and formulated them into tablets. Fenugreek seeds contain steroidal sapogenins and are responsible for the reduction of blood cholesterol levels, control diabetes, enhance breast milk production, digestion aid, and helps in weight loss hence prepared formulation can be recommended in all the above cases. The pre-compression parameters evaluated for formulations are bulk density, tapped density, Carr's index, Hausner's ratio, and angle of repose, and the results are 0.16 gm/cc, 0.86 gm/cc, 14.16, ratio 1.13 and 32°, respectively; whereas post-compression parameters are weight variation, friability, hardness, thickness, and disintegration, and the results are 0.504 gm, 0.2%, 3.21 gm/cm², 2.55 mm, and 7 min, respectively.

Keywords: nanoparticles; fenugreek; steroidal sapogenins; aqueous extract; tablet; evaluation



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1. Introduction

Nanotechnology is a crucial field of recent research handling the blueprint, synthesis, and manipulation of particle structure starting from roughly 1–100 nm in one dimension. In this sized range, the physical, chemical, and biological properties of the nanoparticles change in fundamental ways from the properties of both individuals, atoms/molecules, and of the corresponding bulk materials. Nanoparticles are often made up of materials of diverse chemical nature, the foremost common being metals, metal oxides, non-oxide ceramics, polymers, silicates, carbon, organics, and biomolecules. Nanoparticles exist in several different morphologies like spheres, cylinders, platelets, tubes, etc. [1]. Silver nanoparticles are of interest as possess the unique properties (e.g., size and shape relying on optical, electrical, and magnetic properties), which may be incorporated into antimicrobial applications, biosensor materials, composite fibers, cryogenic superconducting materials, cosmetic products, and electronic components. Several physical and chemical methods are used for synthesizing and stabilizing silver nanoparticles [2,3]. Metallic nanoparticles are prepared by wet chemical synthesis, including chemicals that are fairly often toxic and flammable. Therefore, a consistent and eco-friendly process was used to prepare silver nanoparticles, including aqueous extract of *Trigonella foenum-graecum* (Fenugreek) seeds, and formulated into tablets using appropriate excipients. Fenugreek seeds possess an

ample range of applications like reducing blood cholesterol levels, controlling diabetes; enhancing breast milk production, aiding in digestion, and facilitating weight loss [4,5].

Sub-chronic treatment of fenugreek seed extract, which contains steroid saponins, boosted food consumption and desire to eat in normal rats, while also causing hyperinsulinemia and lowering plasma total cholesterol levels. Saponins are a diverse collection of chemicals that are found mostly in plants. These glycosides, which are made up of a sterol or triterpene ring with sugars attached, have tensio-active characteristics that are well recognized for complexing cholesterol in cell membranes. In fact, these triterpenoid saponins have been shown to lower plasma cholesterol levels by forming insoluble complexes with cholesterol in the digestive system and excreting them in the stool [6].

2. Materials and Methods

2.1. Collection

The fenugreek seeds were purchased from the local market of Shahada, Dist-Nandurbar (M.S).

2.2. Preparation of Dried Biomass

The seeds were carefully cleaned and crushed with deionized distilled water. The powder was also utilized to make aqueous seeds extract at a concentration of 10 g/L. This extract was filtered and kept at 4 °C until it was needed for the current study [7].

2.3. Chemicals

Silver Nitrate (AgNO_3), and throughout the experiment, deionized distilled water were utilized. The rest of the chemicals were of analytical quality.

2.4. Synthesis of Saponin-Coalesced Silver Nanoparticles

First, 2.0 mL plant seeds extract was combined with 25 mL of newly produced silver nitrate 10-3M AgNO_3 solution in 250 mL deionized water in a sterile conical flask and stored in the dark at room temperature for biogenesis of nanoparticles. The reaction mixture was incubated for 30 min or until a dark pink color shift was noticed. After that, the nanoparticles were synthesized by drying them at 90 °C [7]. The observations after incubation are mentioned in results and depicted in Figure 1.

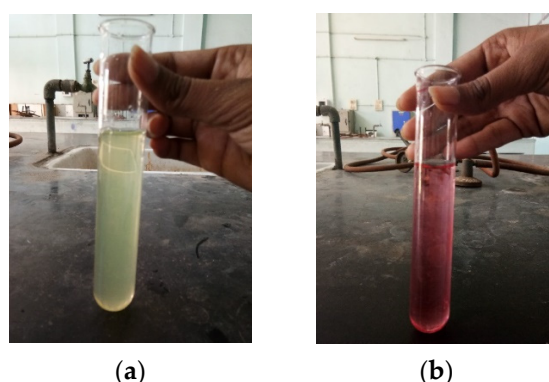


Figure 1. (a) Aqueous seed extract; and (b) aqueous extract and silver nitrate after incubation.

2.5. Identification Test for Steroidal Saponins (Diosgenin)

2.5.1. Libermann Burchard Test

Within the aqueous extract of fenugreek seeds were added a couple of drops of acetic anhydride, boiled and cooled, added conc. H_2SO_4 from the side of the tube, brown ring at the junction of two layers, and the upper green layer indicate the presence of steroids [8,9].

2.5.2. Salkowski Test

Within the aqueous extract of fenugreek seeds were added few drops of concentrated H_2SO_4 red color at lower layer indicates the presence of steroids [8,9].

2.6. Preparation of the Tablets

The direct compression method was used to make the tablets. The formula for the solitary tablet per batch required to prepare 200 mg of a tablet is given in Table 1. The required quantity of disintegrant, binder, diluents, and anti-adherent were passed through sieve no. 80 separately and then mixed with the assistance of mortar pestle, then the resultant powder was compressed into tablets by using a single punch rotary compression machine [9]. The observations of tablets are mentioned in results and depicted in Figure 2.

Table 1. Formula for the preparation of herbal tablet.

Sr. No.	Ingredients for Tablet	Formulation (mg)
1	Silver nanoparticles of Fenugreek seed	10
2	Xanthan gum	30
3	Talc	20
4	Magnesium Stearate	05
5	Ethylcellulose	30
6	Lactose	Q.S. to get 200 mg Tablet



Figure 2. Tablets formulated from fenugreek seed silver nanoparticles.

2.7. Pre-Compression Evaluation

All pre-compression characteristics were assessed, including bulk density, tapped density, Carr's index, Hausner's ratio, and angle of repose. The examination was carried out according to the Indian Pharmacopoeia's procedure [10–12].

2.8. Post-Compression Evaluation of Compressed Tablets

2.8.1. Weight Variation

Arbitrarily picked 20 tablets were taken for weighing one by one and also collectively in the single pan balance. The standard deviation was determined after getting the average weight. The tablet passes the test if not more than two tablets fall outside the proportion limit. Weight variation test for the tablet of all the batches was carried out as per IP (weight variation limit is 5%).

2.8.2. Friability

Friability test was carried out by Roche friabilator. Pre-weighted 10 tablets were allowed for 100 revolutions in 4 min and were de-dusted. The percentage of weight loss

was calculated by reweighing the tablets. The percentage of friability was calculated by an equation:

$$F = \frac{W_{\text{initial}} - W_{\text{final}}}{W_{\text{initial}}} \times 100 \quad (1)$$

where, F = Friability; W initial = weight of tablet before performing the test; and W final = weight of tablet after performing the test.

2.8.3. Hardness

The Monsanto hardness tester was employed to determine the tablet hardness. The sample tablet was seized in between moving and affixed jaw of tester. The scale was adjusted to zero; the load was gradually increased until the tablet is fractured. The value of the load at that time gives a measure of the hardness of the tablet, which was expressed in kg/cm².

2.8.4. Thickness

Vernier caliper was employed to find the thickness of the prepared tablets. The obtained results were articulated as mean values of ten findings.

2.8.5. Disintegration Test

The apparatus (USP) has six glass tubes that are three inches long, open at the top, and kept against a ten-mesh screen at the base ending of the basket rack assembly. One tablet is placed in each tube, and a basket rack is positioned in a 1-L beaker of water or imitation gastric fluid, at 37 ± 2 °C, such that the tablet remains underneath the surface of the liquid on their rising movement and move down not nearer than 2.5 cm from the base of the beaker. Suspend the assembly in the beaker containing water and operate the apparatus. Remove the assembly from the liquid. Proviso that all the tablets get disintegrated, we can say they passed the test [10–12].

3. Results

Silver nanoparticles from fenugreek seeds were synthesized by reducing method. The reaction mixture showed a color change to dark pink, confirming the presence of silver nanoparticles in it.

The presence of steroidal sapogenins was confirmed by the chemical identification tests.

Silver nanoparticles were formulated into tablets, and the result for pre-compression evaluation obtained are the weight of powder 23.2 gm, bulk density 0.16 gm/cc, tapped density 0.86 gm/cc, Carr's index 14.16, Hausner's ratio 1.13, angle of repose 32° and post-compression tests were performed, and this test was passed as per mentioned in I. P., and the result for the same is mentioned in Tables 2 and 3.

Table 2. Pre-compression evaluation tests.

Sr. No.	Parameter	Formulation
1	Weight of powder	23.2 gm
2	Bulk density	0.16 gm/cc
3	Tapped density	0.86 gm/cc
4	Carr's index	14.16
5	Hausner's ratio	1.13
6	Angle of repose	32°

Table 3. Post-compression evaluation tests.

Sr. No.	Parameter	Formulation
1	Weight variation	0.504 gm
2	Friability	0.2 percent
3	Hardness	3.21 kg/cm ²
4	Thickness	2.55 mm
5	Disintegration	7 min

The results for the post-compression evaluation obtained are weight variation 0.504 gm, friability 0.2%, hardness 3.21 kg/cm², thickness 2.55 mm, and disintegration 7 min, and these tests were passed as mentioned in I.P.

4. Discussion

Amongst many metallic nanoparticles taken into consideration for biomedical claims, the silver nanoparticles are said to be most imperative and captivating. In the field of nano-medicine, silver nanoparticles play a crucial character ranging from antibacterial to anticancer [13]. Synthesizing metal nanoparticles employing herbs called the Green loom is admired and has also become a plunge vicinity of remedial research [14–17]. Plentiful studies exist on the utilization of medicinal foliage in the amalgamation of silver nanoparticles [18,19]. Solitarily silver possesses convincing anti-microbial activity together with anti-inflammatory, anti-oxidant, and anti-fungal actions [20]. The steroidal saponin (Diosgenin) present in the aqueous extract of fenugreek seeds is a bio-active phyto-constituent, and when it combines with silver nanoparticles it becomes a more potent medication. In recent scenarios, such saponin-coalesced silver nanoparticles encompass improved bio-efficacy and are found to be extra fascinating [21,22].

5. Conclusions

The conventional formulations of fenugreek seed extract like tablet and powder are available in the market, but the tablet formulated from silver nanoparticles using fenugreek seed extract will be more advantageous because the nanoparticles are of great interest due to their extremely small size and large surface area to volume ratio, which lead to both chemical and physical difference in their properties compared to the bulk of the same chemical composition, such as mechanical, biological and steric properties, catalytic activity, thermal and electrical conductivity, optical absorption and melting point.

Overall, saponin-coalesced silver nanoparticles look to be promising in pharmaceutical, biomedical, and allied sectors due to their unique characteristics of silver and nano size, assuming that safety data is developed to establish their safety while concurrently eliminating their toxicity.

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