



FORMULATION AND EVALUATION OF A POLYHERBAL CANDY CONTAINING KALANCHOE PINNATA, DOOBGRASS AND BARLEY FOR THE MANAGEMENT OF KIDNEY STONE

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DOI: <https://doi.org/10.5281/zenodo.21788067>

How to cite this Article: Janhavi Thakur, Shreya Thakare, Jitu Turkar, Tejas Umak, Parikshit Bambal, Kanchan Makade, *Shailesh Pise, Dinesh Wanjari, Prasad Jumade. (2026). Formulation and Evaluation of A Polyherbal Candy Containing Kalanchoe Pinnata, Doobgrass And Barley For The Management of Kidney Stone. World Journal of Pharmaceutical and Life Sciences, 12(8), 159-165.

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Article Received on 05/07/2026

Article Revised on 25/07/2026

Article Published on 04/08/2026

ABSTRACT

Kidney stones are among the most frequently occurring chronic urological disorders, which involve the formation of crystals or stones formed as a result of the supersaturation and crystallogenesis of certain solutes like calcium, oxalates, and uric acid within the renal system. Herbal medicines represent safe and multi-targeted approaches for the management of such disorders via diuretic, anti-oxidant, alkalizing, and anti-crystallization effects. The current study is dedicated to creating an easy-to-use herbal candy using three known herbs of antilithiatic and nephroprotective actions such as *Kalanchoe pinnata*, *Cynodon dactylon*, (Doobgrass), and *Hordeum vulgare* (barley seeds). As a natural candy base, jaggery was chosen for its beneficial nutritional properties, excellent binding activity, and stabilization effect on herbal compounds when heated. Candy formulations consisting of three different forms of barley (as extract, roasted seeds, or fine seed powder) were developed according to standard candy-making procedures (decoction, boiling, jaggery melt, mixing, molding). The three samples were compared based on organoleptic parameters, weight uniformity, hardness, friability, thickness, texture, and stability. Barley extract failed to provide adequate binding, resulting in soft, sticky candy. Roasted barley seeds increased brittleness and reduced palatability. The batch containing fine barley seed powder demonstrated the most desirable characteristics, including optimal hardness, smooth texture, uniform weight, and improved stability. Moreover, barley powder retained natural fibres, soluble beta-glucans, and alkalizing compounds, enhancing both candy structure and therapeutic potential. Overall, the optimized polyherbal candy shows promise as an effective, palatable, and convenient nutraceutical supplement for supporting kidney stone prevention and urinary health. Its formulation combines diuretic, antioxidant, and anti-crystallization actions of the selected herbs with the nutritional benefits of jaggery. Further work, including phytochemical quantification, in-vitro anti-lithiatic evaluation, and clinical validation, is recommended to confirm its efficacy and establish it as a standardized herbal dosage form.

KEYWORDS: Kidney stones, Urological Disorders, Crystallogenesis, Calcium, Oxalates, Uric Acid, Herbal Medicines, Diuretic, Antioxidant, Alkalizing, Anti-crystallization, *Kalanchoe pinnata*, *Cynodon dactylon*, *Hordeum vulgare*, Jaggery, Barley extract, Roasted Barley Seeds, Fine Barley Seed Powder, Nephroprotective Actions, Nutraceutical Supplement, Urinary Health.

1. INTRODUCTION

1.1 Kidney stones

The prevalence rate of kidney stone disease has witnessed an appreciable rise over the past two decades, and presently, it is estimated to occur within 1-15 % of

humans globally. Kidney stones are minute crystalline deposits composed of biominerals occurring in the kidney, ureter, and bladder. An increased susceptibility to kidney stone deposition results from the presence of high concentrations of stone-forming components like

calcium, ammonium, oxalate, carbonate, and phosphate ions, as well as macromolecules in the urine. Dehydration exacerbates this process by increasing the urine concentration.^[1]

1.2 Herbal medicine

Herbal medicine has been a common practice used to cure disease, some of which involve the urinary system. Herbal medicine can be used to treat acute nephrolithiasis as it involves no incisions, is cost-effective, and has the ability to contain properties that may disintegrate or dissolve kidney stone.^[2]

1.3 Kalanchoe pinnata

Kalanchoe pinnata is one of the medicinal plants widely employed in treating kidney stones and other related ailments. The herb possesses anti-Urolithiatic activity that could help in inhibiting calcium oxalate kidney stones development and growth. Due to its diuretic property, *Kalanchoe pinnata* could facilitate the excretion of kidney stone-forming materials through increased urine production.^[3]

1.4 Doobgrass

The Doobgrass (*Cynodon dactylon*) is one of the herbal plants used in Ayurveda for the treatment of several urinary and renal ailments. This herb shows great diuretic effect due to which it helps to increase the secretion of urine and expel toxins out of the urinary tract system. Researches show that this herb increases urine production, helping the kidneys work properly along with detoxifying the body of any harmful substances.^[4]

1.5 Barley

Barley (*Hordeum vulgare*) is a grain full of nutrition and recognized for its beneficial effects on kidney and urinary tract health. Barley is known for its natural diuretic properties, which promote urine output and aid in the removal of metabolic waste from the urinary tract. Consumption of barley can be helpful in preventing or treating kidney stones through proper renal functions.^[5]

1.6 Jaggery

Jaggery is a traditional natural sweetener obtained by processing sugarcane juice without refinement, centrifugal treatment, or additives. It contains significantly higher mineral content than refined and brown sugar. In Ayurveda, jaggery is considered an important base ingredient for the preparation of various medicinal formulations.^[6]

1.7 Citric acid

Citric acid imparts a pleasant sour taste, lowers the pH, and possesses antioxidant properties that contribute to enhanced shelf-life and product stability.^[7]

1.8 Cardamom

Cardamom is a highly valued spice widely used as a flavoring agent in foods and beverages. It is utilized in

both whole-seed and powdered forms to enhance the taste and aroma of various products. Additionally, cardamom has traditional medicinal applications.^[8]

1.9 Herbal candy

Candy is an edible confectionery that can be made from fruits and vegetables which are immersed in syrups and other substances for flavoring purposes and also for improving its properties. The presents day candies contain medicinal herbs which add to their nutritive as well as curative aspects. Some advantages of herbal candies are that they provide improved flavor, patient compliance, antioxidants and phyto-compounds.^[9]

This combination of therapeutic herbs and natural excipients forms a stable, palatable and effective herbal candy designed to support kidney stone management through diuretic, antioxidant, and anti-crystallization actions.

2. Plant Profile

2.1 Kalanchoe pinnata



Fig. 1: *Kalanchoe pinnata*.

Synonyms

Bryophyllum pinnatum, *Bryophyllum calycinum*

Biological source

Kalanchoe pinnata consists of the fresh or dried leaves of *Kalanchoe pinnata* (Linn.) Pers., a succulent perennial medicinal herb.

Family

Crassulaceae

Botanical description

Kalanchoe pinnata is a succulent perennial herb growing up to 1-1.5m in height. The leaves are opposite, fleshy, dark green and 10-20 cm long with scalloped margins. The flowers are bell shaped and pendulous with a reddish-purple corolla. The fruits is a pod containing numerous ellipsoid seeds.

Chemical constituents

Kalanchoe pinnata contains flavonoids (quercetin, kaempferol, rutin), triterpenoids, steroids (beta-sitosterol), glycosides, alkaloids, and bufadienolides (Bryophyllin A & B). It also contains vitamins, minerals, and fatty acids that contribute to its medicinal properties.

Uses

Kalanchoe pinnata is traditionally used for Kidney stones and Urinary disorders, Wound healing and Cuts, Gastrointestinal problems (Diarrhoea, Dysentery, Indigestion), Jaundice, Respiratory disorders (Cough and Asthma), and Bronchial disorders, Headache and Inflammation, Diabetes, Bruises, Insect bites, and Skin diseases such as scabies.^[10]

2.2 Doobgrass (*Cynodon dactylon*)



Fig. 2: Doobgrass.

Synonyms

Cynodon dactylon, Bermuda grass, Doob (Hindi), Dhoorva (Marathi).

Biological source

The biological source of doobgrass is *Cynodon dactylon* (L.) Pers. Depending on the therapeutic preparation, the whole plant, leaves, aerial parts, or rhizomes might be used.

Family

Poaceae

Botanical description

It is a perennial grass characterized as a creeper. It is classified as a weed and is distributed globally. It is particularly native to warm temperature and tropical regions, including East Africa, Asia, Australia, and southern Europe.

Chemical Constituents

Primary nutrients such as Proteins (10.47% crude protein on dry basis), carbohydrates, fibers, minerals and vitamin C. Flavonoids such as Apigenin, luteolin, orientin, and vitexin. Carotenoids such as Beta-carotene, neoxanthin, and violaxanthin. Major bioactive volatiles and fatty acids such as Glycerin, palmitic acid, phytol, tricosane, hexadecanoic acid ethyl ester, and linolenic acid ethyl ester. Phenolic compounds such as hydroquinone, furfural, and levoglucosenone. Alkaloids, glycosides, saponins, phytosterols, and triterpenoids are also present.

Uses

Urinary disorders, Kidney stones, Cough, Headache, Cramps, and Epilepsy. Diarrhoea, Dysentery, Dropsy, and Urogenital disorders. Hemorrhage, Hypertension, Diabetes, Hysteria, and Measles. Snakebites, Sores,

Tumors, Warts, and Minor injuries. Its rhizomes are also used as a diuretic, antiemetic, and blood purifier.^[11]

2.3 Barley (*Hordeum vulgare*)



Fig. 3: Barley seeds.

Synonyms

Hordeum vulgare L., *Hordeum distichon* L.

Biological source

Barley is a flowering vascular seed plant(angiosperm) belonging to the genus *Hordeum*. It consists of the dried grains of *Hordeum vulgare* L.

Family

Poaceae (also commonly known as the grass family or Gramineae).^[12]

Botanical description

Barley kernels are spindle-shaped, 7-12mm long, and can be 2 or 6 rowed. They are classified as hulled, thin-hulled, or hullless. The kernel consists of an outer hull enclosing the caryopsis, which contains Pericarp and Integuments (The outer wall and seed coat), Aleurone layer (The blue or white outer endosperm layer), Endosperm (a starchy mass in a protein matrix), Embryo (the germ located on the dorsal side).

Chemical constituents

Starch (60-64%) made of amylose and amylopectin. Proteins (8-15%) such as albumins, globulins, hordeins, and glutelins. Fiber/Polysaccharides composed of arabinoxylans (4.4-7.8%), beta-glucans (3.6-6.1%) and cellulose (1.4-5.0%). Lipids (2-3%) mainly non-polar lipids rich in linoleic acid. Tocols such as antioxidant tocopherols and tocotrienols. Sugars and ash(2-3%each) such as simple sugars, oligosaccharides, B-complex, vitamins and minerals.

Uses

Pearled barley, flakes, and flour for soups, cereals, and baking, Major use (80-90%) for feeding livestock and poultry, in brewing as primary ingredient for malt, beer, and distilled spirits, beta-glucans and tocopherols present in it lower cholesterol and blood glucose, Fermented to produce bioethanol for biofuel production.^[13]

It is also traditionally used as a diuretic, demulcent, emollient, and nutritive tonic. It is used in urinary tract disorders such as kidney stones and cystitis and is also used for digestive ailments, fever, and diabetes.^[14]

2.4 Jaggery



Fig. 4: Jaggery(gud).

Jaggery is a natural product that can be prepared either by boiling or processing juice from sugarcane, palmyra

palm, date palm, and coconut palm. It possesses an inherent sweet smell and taste. It contains proteins, minerals, and vitamins. The nutritional value of jaggery is higher than refined sugar because it has high amounts of iron and copper. It can be consumed directly or used in the preparation of various food products due to its natural sweetness. High quality jaggery is characterized by its golden-yellow color, hard, crystalline structure, sweet taste and low moisture content. The typical composition of good-quality jaggery is usually more than 70% sucrose, less than 10% glucose and fructose, below 5% minerals, and less than 3% moisture.^[15]

3. Method of Preparation

3.1 Formulation table

Ingredients	Trial 1	Trial 2	Trial 3 (Optimised)	Role
Kalanchoe pinnata leaves extract	20ml	20ml	20ml	Main antiurolithiatic
Doobgrass leaves extract	15ml	15ml	15ml	Diuretic and antiurolithiatic
Barley seeds	Barley seeds extract-13ml	Roasted barley seeds-13g	Barley seed powder-13g	Diuretic, urine alkalizer, Demulcent
Jaggery	50g	50g	50g	Base of candy
Citric acid	1g	1g	1g	Natural preservative, pH adjuster, Flavour enhancer
Cardamom powder	1g	1g	1g	Flavouring agent, improves aroma and palatability

Total quantity-100ml

3.2 Procedure

1. The specified amount of freshly plucked *Kalanchoe pinnata* leaves and doobgrass leaves was taken, washed properly, and made into extracts through the
2. Jaggery was slowly melted at temperatures of 90-100 °C, thereby making it a uniformly syrupy substance.



Fig. 5: Fresh leaves of *Kalanchoe pinnata*, Doobgrass and Barley seeds.

3. Thereafter, the concentrated extracts of *Kalanchoe pinnata* and doobgrass were combined, followed by continuous stirring in order to make a uniform mixture.
4. This mixture was further heated to a temperature range of 120-130 °C, resulting in a candy syrup-like consistency.
5. Barley seed powder was added slowly with stirring until the mixture had a smooth texture. To give flavor, cardamom powder and citric acid were included.
6. The prepared mixture was then placed into molds or greased trays and left to cool so that it solidifies and get hardened.
7. Lastly, the herbal candy was packed into airtight, moisture-proof containers.

3.3 Phytochemical Screening

Sr no.	Phytoconstituents	Present/Absent
1	Carbohydrates	Present
2	Alkaloids	Present
3	Glycosides	Present
4	Terpenoids	Present
5	Protein and Amino acids	Present
6	Saponins	Present
7	Flavonoids	Present
8	Phenols and Tannins	Present

4. Evaluation parameters

The herbal candy was successfully formulated using aqueous extracts of *Kalanchoe pinnata* leaves, doobgrass leaves and barley seeds with jaggery, citric acid, and cardamom powder as excipients.



Fig. 6: Prepared final herbal candy.

1. Colour Examination

Candy was placed on a white watch glass and observed visually under daylight for uniformity of colour.

2. Odour Examination

Candy was smelled directly to determine the characteristic herbal odour.

3. Taste Examination

Candy was placed on the tongue and taste was noted.

4. Uniformity of weight

Weigh 10 candies individually on an analytical balance. Calculate the average weight and compare each candy weight with the average.

Deviation should not exceed $\pm 5\%$ for candies $>250\text{mg}$.



Fig. 7: Weighing balance.

Sr no.	Weight(g)	Deviation(g)	Percent deviation
1	8.92	-0.01	-0.11%
2	8.95	+0.02	+0.22%
3	8.90	-0.03	-0.33%
4	8.88	-0.05	-0.56%
5	8.97	+0.04	+0.45%
6	8.93	0.00	0%
7	8.91	-0.02	-0.22%
8	8.94	+0.01%	+0.11%
9	8.89	-0.04	-0.45%
10	8.96	+0.03	0.34%

Average weight of 10 candies = $89.35/10 = 8.93\text{g}$

$8.93\text{ g} = 8930\text{mg}$

Deviation(g)

Deviation = Individual weight - 8.93

Percent deviation

% deviation = $(\text{Deviation}/8.93) \times 100$

Range of percent deviation = -0.56% to 0.45%

As average weight is 8930mg (more than 250mg) allowed deviation is $\pm 5\%$

$8.93 + 5 = 13.93$

$8.93 - 5 = 3.93$

Range is 3.93 to 13.93

The weight of all the candies fall in this range.

So, the candies successfully meet the requirement for uniformity of weight.

5. Friability

Weigh 10 candies (initial weight). Place in friability tester at 25rpm for 4 minutes (100 rotations). Remove, dedust and reweigh.



Fig. 8: Friability Tester.

Sr no.	Initial wt(g)	Final wt(g)	Loss
1	9.10g	9.08g	0.02
2	8.92g	8.90g	0.02
3	9.05g	9.03g	0.02
4	8.95g	8.93g	0.02
5	9.12g	9.10g	0.02
6	8.88g	8.86g	0.02
7	9.08g	9.06g	0.02
8	9.02g	9.00g	0.02
9	8.91g	8.89g	0.02
10	9.07g	9.05g	0.02

Total initial weight = 90.10g

Total final weight = 89.90g

Loss = Initial weight - Final weight = $90.10\text{g} - 89.90\text{g} = 0.20\text{g}$

Friability(%) = $\text{Loss}/\text{Initial weight} \times 100 = 0.20\text{g}/90.10 \times 100 = 0.22\%$

Friability was found to be 0.22%.

6. Hardness



Fig. 9: Pfizer Hardness Tester.

No. of candy	Breaking force(kg)
1	6.2
2	6.0
3	6.3
4	6.1
5	6.2

Average hardness of 5 candies was found to be 6.1kg

7. Thickness



Fig. 10: Vernier Calliper.

No. of candy	Thickness
1	5.6mm
2	6mm
3	6.4mm
4	6.8mm
5	7.1mm

Average thickness of 5 candies was found to be 6.38mm

8. PH

Prepared final candy solution used to measure the pH.

9. Stability

Stability checked at the room temperature for 1-2months.

5. RESULT

Evaluation table for 3 batches

Sr no.	Evaluation parameters	Trial 1	Trial 2	Trial 3
1	Colour	Brown	Brown with white seeds	Light brown
2	Appearance	Clear and smooth	Slightly opaque	Smooth, uniform
3	Texture	soft	Slightly firm	Optimal firmness
4	Hardness/Stickiness	Little sticky	Hard	Optimised
5	Taste	Mild sweet,herbal	Roasted flavour, Stronger taste	Balanced herbal and barley taste
6	Overall acceptability	Moderate	Good	Excellent

Trial 3/Batch 3 was found to be optimized batch for candy formulation.

Evaluation table for optimized batch

Sr no.	Evaluation parameters	Result
1	Colour	Light brown
2	Odour	Pleasant herbal
3	Taste	Balanced herbal and barley taste
4	Uniformity of weight	Uniform
5	Friability	0.22%
6	Hardness	6.1kg
7	Thickness	6.38mm
8	Appearance	Smooth,Uniform
9	Texture	Optimal firmness
10	Overall acceptability	Excellent
11	Stability	Stable
12	PH	5.5

6. DISCUSSION

There were three trials conducted for the herbal candy preparation in order to determine the best composition for future manufacturing. The only variable in all the experiment was the type and the processing of barley seeds that act as a binder and stabilizer for the candy and serve as an ingredient for dissolving kidney stone. The evolution of results shows the impact of physical characteristics of barley on the structure and texture of the final product. First, barley extract was used as the basis of the candy. Despite being rich in phytonutrients, barley extract does not contain fibers necessary for the binding and mass formation in confectionery products. For this reason, the candy had become soft, sticky, and fragile, failing to maintain the desired shape. This shows that barley extract cannot be applied as a solid substance

for creating a candy. Second, lightly roasted barley seeds were used to achieve better structure and lower moisture content. Nevertheless, roasting made the barley more brittle and less capable of absorbing moisture, which led to an overly hard candy. This proves that roasting brings about changes in the nature of starch and proteins in barley resulting into a rigid body not appropriate for the manufacture of soft chewable candies. The third batch of candy was made from fine barley seed powder. Barley seed powder was effective in enhancing cohesion properties in the candy formulation because of starch and soluble fiber (β -glucans) contained within it. Moreover, it absorbed excess moisture from extracts of kalanchoe pinnata and doobgrass, which prevented the candy from being sticky. On the other hand, it ensured appropriate softness in candy formulation. This batch exhibited the

required level of stability and consistency. Thus, barley seed powder is the most appropriate choice for candy formulation. Raw barley seed powder works well in the treatment and prevention of kidney stones since it retains natural fibers, diuretics, and alkalizing agents. On the other hand, light roasted barley seeds are good only for use as textural enhancer in foods but not as a kidney stone treatment formulation. Consequently, from the batch comparison, it is clear that selection of the correct physical form of herbal materials is very important in confectionary formulation of herbal candy to prevent kidney stones.

7. SUMMARY AND CONCLUSION

Herbal candy used in the management of kidney stones was prepared using ingredients like *Kalanchoe pinnata*, Doobgrass, barley, jaggery and cardamom. Three types of barley preparations were tested including extract preparation, roasted seeds of barley, and raw barley seeds powder. Extract of barley resulted in sticky and unstable candies whereas roasted barley seeds gave very hard candies with low therapeutic properties. On the other hand, use of raw barley seed powder resulted in the optimal preparation with the desired characteristics along with retention of biological substances like β -glucan and saponins. The optimal formulation had excellent compatibility between all components, leading to the production of a smooth, tasty, and stable candy. As such, it could be concluded that raw barley seed powder was the best form of barley, which not only ensured product stability but also exhibited improved antiurolithic potential.

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