International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 1164-1172 www.ijprajournal.com ISSN: 2249-7781

Preparation of Anti-diabetic nutraceutical hard candies From different herbal extracts

Mrs. Sheetal Mahajan ; Dr.SmitaTakarkhede ;Vaibhavgawade ; SanskrutiGawade ; SejalGaikwad ; Divyanshu Dubey; Vinod Dubey
Research Guide, Dept. of Pharmaceutics, Ideal College of Pharmacy and Research
Principal, Ideal College of Pharmacy and Research
Research Scholar, Ideal College of Pharmacy and Research, Bhal, Dwarli, Hajimalang Road, Kalyan East, Maharashtra,421306

Submitted: 08-05-2023 Accepted: 20-05-2023

ABSTRACT
Diabetes management focuses on controlled blood glucose levels. The use of natural ingredients such as syzgiumcumini, Costusigneus, GymnemaSylvestre have shown potential in the treatment of diabetes. Hard candies were prepared using this herbs and isomalt a sugar alcohol composed of mannitol and sorbitol was used as a alternative for the base of the sugar-free hard candies and were proposed as complementary therapy for diabetes management. The candies were evaluated according to their quality characteristics such as pH, dissolution, disintegration according to the parameters. The results of the evaluated candies were acceptable thus providing a convinent and tasty alternative to traditional diabetes management method

Keywords : Diabetes control, syzgiumcumini, chamaeocostuscuspidstus, Gymnema Sylvestre, sugar free candies, isomalt

I. INTRODUCTION

The condition known as diabetes mellitus, also known as diabetes, is characterised by the body's inability to properly use or store glucose. Normally, the body converts food into glucose, which is then used by the cells for energy, but in diabetes, the glucose begins to accumulate in the body rather than enter the cells, leading to high blood sugar levels. Blood sugar levels are influenced by the hormones glucagon and insulin, respectively.Both of them are produced by the group of cells called islets of Langerhans.

Type 1 insulin-dependent diabetes and Type 2 non-insulin-dependent diabetes are the two main forms. Polyphagia ipolyurea ,polydipsia hazy vision are some of the signs of diabetes. The diagnosis is made by determining how much glucose is present; it is provided by utilising some specific standards

Treatment includes changing one's lifestyle, medications, monitoring of blood sugar level etc.

Hard candies are a solid dosage form made of sugar and other carbohydrates that come in a variety of shapes. They have a smooth texture and flavour and weigh between 1.5 and 4.5 g.

Hard candies are made to dissolve in the mouth and have an effect.

Ancient medicinal practises of Ayurveda have documented diabetes diagnosis and therapy. GymnemaSylvestre, syzygiumcumini, and costusigneus are a few of the plants used to treat diabetes.

II. MATERIALS AND METHODS:

Materials-

The following materials were used for production of hard candies: • Active ingredients: chamaecostuscuspidatus leaf extract, Gymnemasylvestre leaf extract, jamun seed extract. • Natural flavorings: citric acid, stevia. • Sucrose-free hard candy: Isomalt • Other ingredients: ethanol, methanol, distilled water, glycerine, food colouring

Sample preparation:

1.chamaecostus cuspidatus (insulin plant):

Locally cultivated leaves of chamaecostuscuspidatus were used to produce the extract. The collected leaves were washed, sterilized and shade dried. The shade dried leaves ere powdered to consistency in a grinder mill. The grinded leaves were passed through a 40 # mesh size sieve and stored in airtight container at room temperature until further use.

➢ About 500g air dried leaves powder was used

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 1164-1172 www.ijprajournal.com ISSN: 2249-7781

➢ The powder was macerated with 2.5L Methanol. Simple maceration for 7 days in a conical flask with occasional shaking and stirring was adopted.

➢ Extract was filtered and concentrated at room temperature to avoid the decomposition of natural metabolites; using a rotary evaporator.

➢ Extract was preserved in a refrigerator till further use.

2. Gymnemasylvestre (Gurmar)

Locally cultivated leaves of Gymnemasylvestre were used to produce the extract. The collected leaves were washed, sterilized and shade dried. The shade dried leaves were powdered to consistency in a grinder mill. The grinded leaves were passed through a 40 # mesh size sieve and stored in an airtight container at room temperature until further use.

➢ 100g of the leaf powder was placed in conical flask and soaked in 1000ml of the methanol.

➢ covered with cotton wrapped with aluminium foil.

➢ The flasks were allowed to stay and shaken daily for 5 days after which they were filtered using muslin cloth.

➢ The filtrate was evaporated until it was paste like using the laboratory steam bath. A sticky dark semi-solid extracts were obtained.

Traditional hard candies are prepared on open fire cooking method.

➢ Required amount of isomalt was weighed and taken in a China dish and put on a Bunsen burner for melting.

➢ Stevia is weighed and added.

➢ The isomalt on heating starts forming bubbles due to caramelization.

➢ Use a thermometer to check the temperature and heat it until 70°c.

➢ It was weighed and stored in sterile container and kept in the refrigerator at 4o C for future use.

Syzygiumcumini L (Jamun)

The fruits were rinsed with water and pulped to obtain the Jamun seed and immediately rinsed. The seed coat was then peeled manually to obtain the Jamun seed. The seeds were washed thoroughly using distilled water and utilized to make a powder. Then the Jamun seed have been kept in dyer overnight at 60°Celsius. The dry materials were turned into flour by using a lab grinder and converted to a very fine powder via sieving and again keeping it overnight in a dryer in a sterilized condition. The powdered material was placed in a sterilized jar and retained for future use. Seeds were crushed, dried and ground to fine powder of 60 mesh sieve size.

- Aqueous extract of Syzygiumcumini L was prepared by using 40g of jamun seed powder and using 480ml distilled water
- After mixing together; it was kept for 24 hours at room temperature in sterile environment.
- The liquid extract was then filtered and the filtrate was then kept in a waterbath at 80- 90°c till dried out.

Preparation of traditional hard candies

➢ The conc. macerated extracts are added in the required amount with slow & continuous stirring.

➢ Glycerine , sodium benzoate, citric acid and food colouring is added.

➢ The contents are cooled down till 40°c

➢ The molten contents are poured in a mold of required shape and put in a refrigerator until it hardens.

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 1164-1172 www.ijprajournal.com ISSN: 2249-7781

TABLE 1.1: INGREDIENTS 1.1: INGREDIENTS

FORMULATION	*F1*	*F2*	*F3*	*F4*	*F5*	*F6*
ISOMALT	25.5g	25.5g	25.5g	25.5g	25.5g	25.5g
CHAMAECOSTUS CUSPIDATUS EXTRACT	5%	6%	7%	--	--	--
GYMNEMA SYLVESTRE EXTRACT	--	--	--	5%	6%	7%
SYZYGIUM CUMINI EXTRACT	2%	2%	2%	2%	2%	2%
STEVIA	1g	1g	1g	1g	1g	1g
GLYCERINE	2ml	2ml	2ml	2ml	2ml	2ml
CITRIC ACID	0.18g	0.18g	0.18g	0.18g	0.18g	0.18g
SODIUM BENZOATE	0.2g	0.2g	0.2g	0.2g	0.2g	0.2g
F,D&C DYE	*q.s.*	*q.s.*	*q.s.*	*q.s.*	*q.s.*	*q.s.*

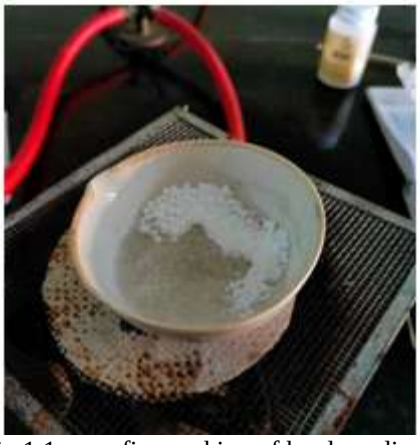

Fig 1.1 open fire cooking of hard candies

➢ The hardened candy is then packed and stored at a suitable temperature.

EVALUATION

Determination of moisture content:

For the determination of moisture content, 5 g sample was taken in petri dish of known weight. The petri dish with the sample was then kept in a hot air oven maintained at a temperature of 80° C. After 3-4 hours, the petri dish were taken out from the oven & kept in a desiccator for cooling. When the petri dish is properly cooled, its weight is recorded. The moisture content of the samples was determined by the following formula:

$$\textbf{Moisture}\ (\%) = \frac{[(w+w1)-w2]}{w} \times 100$$

Where, W = weight of sample (g)
W1= Weight of Petri Dish (g)
W2= Weight of Petri dish with sample after drying (g)

Determination of ash content:

Sample ash content was done by AOAC 942.05 method. For the determination of ash content, we use three silica crucibles and weigh them, and a 5 g sample was taken to each crucible. After the removal of moisture the samples were used for ash determination. The crucible with the sample was kept in a muffle furnace at 400°c temperature for 3-4 hours until the ash was obtained. After that the crucible was cooled in a desiccator and weighed. Weight of ash was expressed in percentage. Ash content of the samples was determined by the following formula:

$$\textbf{Ash}\ (\%) = \frac{w2-w1}{100}$$

Where, w1=initial weight (g)

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 1164-1172 www.ijprajournal.com ISSN: 2249-7781

w2=loss in weight (g)

Determination of pH

pH is the measure of the concentration of hydrogen ions of the solution. It is expressed as a number on a scale from 0-14. A pH electrode is used to measure the pH of the sample. For the determination of pH, we make a suspension of a sample by removing a portion of the sample and put it in a test tube half filled with distilled water. Then the pH electrode isplaced in the test tube and the machine automatically displays the results. Repeat the same procedure for all the samples and note the readings.

Weight variation

The weight variation was conducted by weighing 20 lozenges individually and calculating the average weight and comparing the individual lozenges weight to the average value.

Hardness

Tablet hardness testing is a laboratory technique used by the pharmaceutical industry to determine the breaking point and structural integrity of a tablet and find out how it changes "under conditions of storage, transportation, packaging and handling before usage". The hardness of the lozenges was determined by using Monsanto Hardness tester, where the force required to break the lozenges was noted.

Friability

The friability of the lozenges was determined using Roche Friabilator. Weighed lozenges were placed in the friabilator and operated for 4 min at 25 rpm. The tablets were then made free from dust and reweighed.

Mouth dissolving time test

The time taken by the candy to dissolve completely was determined by the USP Disintegration apparatus, where hard boiled candy lozenges were placed in each tube of the apparatus and time taken for the lozenges to dissolve completely was noted by using MCIlavine buffer of pH 6.4 at 37oC.

In-vitro drug dissolution studies

The rate of dissolution possibly is related to the efficacy of the tablet lozenge. Dissolution study was carried out in 800 ml of MCIlavine buffer pH 6.4 by USP II paddle method at 150 rpm. Samples were withdrawn at 5 min interval and replaced immediately with an equal volume of fresh buffer and were analyzed spectrophotometrically.

Fomultion	Moisture content	Ash content	Weight variation	hardness	friability	Disintegration time	ph
F1	3.67±0.02	0.75±0.01	2.25±0.07	≥20	0.79±0.01	26±1	4.5
F2	3.55±0.01	0.66±0.01	2.18±0.05	≥20	0.77±0.01	25±1	4.4
F3	3.78±0.03	0.59±0.01	2.2±0.05	≥18	0.76±0.01	22±1	4.5
F4	3.1±0.02	0.65±0.01	2.12±0.07	≥20	0.80±0.01	27±1	4.5
F5	3.23±0.03	0.78±0.01	2.13±0.06	≥20	0.76±0.01	26±1	4.4
F6	3.33±0.01	0.80±0.01	2.16±0.05	≥19	0.77±0.01	23±1	4.5

Table 1.2:EVALUATION RESULTS

III. RESULTS

Hardness

Hardness of lozenge is defined as the force applied across the diameter of the lozenge in order to break the lozenge. The resistance of the lozenge to chipping, abrasion or breakage under condition of storage transportation and handling before usage depends on its hardness. For each formulation, the hardness of 2 lozenges was determined using Mosanato hardness tester and the average was calculated and presented with standard deviation.

International Journal of Pharmaceutical Research and Applications
Volume 8, Issue 3 May-June 2023, pp: 1164-1172 www.ijprajournal.com ISSN: 2249-7781

Weight variation test

Twenty lozenges were taken and their weight was determined individually and collectively on a digital
weighing balance. The average weight of one lozenge was determined from the collective weight. The weight variation test would be a satisfactory method of determining the drug content uniformity. The percentage deviation was calculated.

Moisture content analysis

The optimum range of moisture content in the hard candy based lozenges is 3-3.5%.The percentage moisture content of all the prepared hard candy lozenges was found to be < 3.7% as shown.

Ash content

Total ash content was measured and recorded after burning the contents in a cruicible. Ash content is determined to estimate the minerals present in the product.

Ph value

The Ph value was determined to check if the preoductsPh is suitable for oral consumption and is similar to that of the oral mucosa.

Friabilator

It is a measure of mechanical strength of tablets. Roche friabilator was used to determine the friability by following procedure. Pre-weighed lozenges (20 tablets) were placed in the friabilator. The lozenges were rotated at 25 rpm for 4 minutes (100 rotations). At the end of test, the lozenges were re-weighed, loss in the weight of lozenges is the measure of friability and is expressed in percentage.

Dissolution

Hard candy lozenges inherently possess extended release property since the drug is supposed to release from the boiled and congealed candy base.Theformulations FC3 and FC5 showed a release of 95.12% and 96.36% respectively in 30 minutes. The release of FC3 and FC5 was found be good in comparison to other hard candy lozenges; the drug is more uniformly distributed in the lozenge in which isomalt is used as the sugar substitute.

IV. CONCLUSION:

6 different formulations were made with different concentrations of the herbal constituents; out of the 6, F3 and F5 showed optimum results for all tests like hardness, friability, moisture content, ash content, disintegration time, dissolution studies,etc.

The study was successful in preparing anti-diabetic neutraceuticals candies from various local herbs and studying their parameters. Table 2.0 shows the outcomes of different evaluation studies done hard candies. Candies prepared were physically appealing in terms of shape, colour, smell and taste.

Acknowledgement

The present work is an effort to throw some light on “PREPARATION OF ANTI-DIABETIC NEUTRACEUTICAL HARD CANDIES FROM DIFFERENT HERBAL EXTRACTS”. The work would not have been possible to come to the present shape without the able guidance, supervision and help from a number of people.

Foremost, I would like to express my deep and sincere gratitude to Ideal college of pharmacy and research, bhal, Kalyan for giving me the opportunity to work on this project and providing various resources for it's completion.

REFERENCES:

[1]. Souiy, Z., Amri, Z., Sharif, H., Souiy, A., Cheraief, I., Hamden, K. and Hammami, M., 2023. The Use of D-Optimal Mixture Design in Optimizing Formulation of a Nutraceutical Hard Candy. International Journal of Food Science, 2023.

[2]. Jayasree, S., 2014. Diabetes Mellitus: Management and Control.

[3]. Fritzsching, B., 1995. Isomalt in hard candy applications. Manufacturing Confectioner, 75, pp.65-74.

[4]. Jeon, Y., Oh, J. and Cho, M.S., 2021. Formulation optimization of sucrose-free hard candy fortified with cudraniatricuspidata
extract. Foods, 10(10), p.2464.

[5]. Zumbe, A., Lee, A. and Storey, D., 2001. Polyols in confectionery: the route to sugar-free, reduced sugar and reduced calorie confectionery. British Journal of Nutrition, 85(S1), pp.S31-S45.]

[6]. Šmídová, I., Čopíková, J., Maryška, M. and Coimbra, M.A., 2003. Crystals in hard candies. Czech journal of food sciences, 21(5), p.185.

[7]. Kini, R., Rathnanand, M. and Kamath, D., 2011. Investigating the suitability of Isomalt and liquid glucose as sugar substitute in the formulation of Salbutamol sulfate hard candy lozenges. J Chem Pharm Res, 3(4), pp.69-75.

[8]. Sentko, A. and Willibald-Ettle, I., 2012. Isomalt. Sweeteners and sugar alternatives in food technology, pp.243-274.

[9]. Hu, C.H., He, J., Eckert, R., Wu, X.Y., Li, L.N., Tian, Y., Lux, R., Shuffer, J.A., Gelman, F., Mentes, J. and Spackman, S., 2011. Development and evaluation of a safe and effective sugar-free herbal lollipop that kills cavity-causing bacteria. International journal of oral science, 3(1), pp.13-20.

[10]. Pashikanti, S., Kari, T.S.S. and Snehalatha, G., 2022. Formulation and Evaluation of Guaifenesin Hard Candy Lozenges. Asian Journal of Organic & Medicinal Chemistry.

[11]. Namdev, A., Mishra, S., Sharma, D., Soni, S. and Jain, D., 2022. Unexplored Potential of Medicated Candies And Lozenges as a Drug Delivery System. Contemporary Advances in Science & Technology-V: Pharmaceutical Chemistry and Technology, p.41.

[12]. Deis, R.C. and Kearsley, M.W., 2012. Sorbitol and mannitol. Sweeteners and sugar alternatives in food technology, pp.331-346.

[13]. Willibald-Ettle, I. and Schiweck, H., 1996. Properties and applications of isomalt and other bulk sweeteners. Advances in sweeteners, pp.134-149.

[14]. Heume, M. and Rapaille, A., 1996. Versatility of maltitol in different forms as a sugar substitute. Advances in Sweeteners, pp.85-108.

[15]. Washburn, C. and Christensen, N., 2012. Sugar substitutes: artificial sweeteners and sugar alcohols.

[16]. Fontana, M. and González-Cabezas, C., 2012. Are we ready for definitive clinical guidelines on xylitol/polyol use?. Advances in dental research, 24(2), pp.123-128.

[17]. Ibrahim, O.O., 2016. Sugars alcohols: Chemical structures, manufacturing, properties and applications. EC Nutr, 6, pp.817-824.

[18]. RacolŃa, E., Socaciu, C., Mureşan, V., Socaci, S., Nicula, A., Hodrea, M. and Şchiop, T., COMPARATIVES TECHNOLOGIES FOR DIETETIC CANDIES PRODUCTION.

[19]. Jamieson, P.R., Le, A.S. and Mulderrig, K.B., 2012. Sorbitol and mannitol. Alternative sweeteners. CRC Press, Taylor & Francis Group, Boca Racton.

[20]. de Cock, P., 2012. Erythritol. Sweeteners and sugar alternatives in food technology, pp.213-241.

[21]. Flambeau, M., Respondek, F.E.E. and Wagner, A., 2012. Maltitol syrups. Sweeteners and sugar alternatives in food technology, pp.309-330.

[22]. Zacharis, C., 2012. Xylitol. Sweeteners and sugar alternatives in food technology, pp.347-382.

[23]. Tananuwong, K. and Pabhasiriwart, P., 2017. Impact of hydrogenated starch hydrolysate on glass transition, hygroscopic behavior and crystallization of isomalt-based systems. Songklanakarin Journal of Science & Technology, 39(1).

[24]. Eberhardt, L., 2001. Hydrogenated starch hydrolysates and maltitol syrups. FOOD SCIENCE AND TECHNOLOGY-NEW YORK-MARCEL DEKKER-, pp.255-264.

[25]. Pothu, R. and Yamsani, M.R., 2014. Lozenges formulation and evaluation: A review. IJAPR, 1, pp.290-294.

[26]. Campus, G., Cagetti, M.G., Cocco, F., Sale, S., Sacco, G., Strohmenger, L. and Lingström, P., 2011. Effect of a sugar-free chewing gum containing magnolia bark extract on different variables related to caries and gingivitis: a randomized controlled intervention trial. Caries Research, 45(4), pp.393-399.

[27]. Nithya, S., 2019. Formulation Development and Evaluation of Metoclopramide Hydrochloride Medicated Hard Candy Lozenges (Doctoral dissertation, College of Pharmacy, Madras Medical College, Chennai).

[28]. O'Donnell, K. and Kearsley, M.W., 1988. Sweeteners and Sugar Alternatives in Food Technology.

[29]. Kini, R., Rathnanand, M. and Kamath, D., 2011. Investigating the suitability of Isomalt and liquid glucose as sugar

substitute in the formulation of Salbutamol sulfate hard candy lozenges. J Chem Pharm Res, 3(4), pp.69-75.

[30]. Gopale, O., Jethawa, S. and Shellie, S., 2022. Medicated lozenges: a review. Asian Journal of Pharmaceutical Research and Development, 10(2), pp.129-134.

[31]. Rashid, G., Rampal, M., Sujit, P. and Nilesh, B., 2021. A review on medicated lollipops. Research Journal of Pharmacognosy and Phytochemistry, 13(1), pp.33-38.

[32]. Pothu, R., Aparna, A. and Rao, Y.M., 2015. Development and in-vitro evaluation of chlorhexidine and flurbiprofen hard candy lozenges. International Journal of Pharmaceutical Sciences and Research, 6(8), p.3380.

[33]. Chaudhari, P.V., Chaudhari, N.G., Chaudhari, P.S., Patil, A.M. and Pawar, S.P., 2019. Formulation And Evaluation Of Medicated Candy Containing Albendazole For Pediatric. Indian Journal Of Drugs, 7(2), pp.73-80.

[34]. Choursiya, S. and Indurkhya, A., 2020. Development and evaluation of hard candy lozenges containing roxithromycin for treatment of oral infection. Asian Journal of Pharmaceutical Analysis, 10(3), pp.150-154.

[35]. Joshi, R., Soni, D. and Gupta, A., FORMULATION OF SUGARLESS MEDICATED LOGENGES FOR DIABETIC PATIENTS. Advances in Biomedical and Healthcare Science Volume I, p.1.

[36]. Halim, Y., Day, N.H. and Hardoko, H., 2022. Application of guava leaf extract on hard candy to inhibit upper respiratory tract infection caused by bacteria. Brazilian Journal of Food Technology, 25.

[37]. Renuka, P. and Shayeda, Y.M., 2014. Development And In-Vitro Evaluation of Nicotine Hard Candy Lozenges For Smoking Cessation. Int J Pharm Sci, 6(2), pp.626-629.

[38]. Akib, N.I., Baane, W. and Fristiohady, A., 2016. Formulation of herbal hard candy contains red ginger (Zingiberofficinale var. rubrum) extract. Jurnalfarmasi UIN Alauddin Makassar, 4(1), pp.1-8.

[39]. Patil, M., Raizaday, A. and Raut, V., 2020. Formulation and Evaluation of Herbal Candy Based on Indian Medicinal Plants for Cancer Therapy via Immunomodulation. SGVU J Pharm Res Edu, 5(2), pp.562-73.

[40]. Ponnanikajamideen, M., Rajeshkumar, S., Vanaja, M. and Annadurai, G., 2019. In vivo type 2 diabetes and wound-healing effects of antioxidant gold nanoparticles synthesized using the insulin plant Chamaecostuscuspidatus in albino rats. Canadian journal of diabetes, 43(2), pp.82-89.

[41]. Ponnanikajamideen, M., Rajeshkumar, S. and Annadurai, G., 2016. In vivo antidiabetic and in vitro antioxidant and antimicrobial activity of aqueous leaves extract of Chamaecostuscuspidatus. Research Journal of Pharmacy and Technology, 9(8), pp.1204-1210.

[42]. Shukla, V., Bajpai, V., Singh, P., Rai, P., Khandelwal, N., Gaikwad, A.N., Singh, B. and Kumar, B., 2022. Identification and quantification of phytochemicals of Chamaecostuscuspidatus (Nees& Mart.) CD Specht & DW Stev and Cheilocostusspeciosus (J. Koenig) CD Specht by LC-MS techniques and their in-vitro anti-adipogenic screening. Natural Product Research, pp.1-5.

[43]. Kaur, M. and Mannan, A., 2021. In vitro Antidiabetic Activity of Chamaecostuscuspidatus. Pharmacognosy Research, 14(1).

[44]. Deogade, M.S., Ambatkar, N. and Ambatkar, B., 2017. Anti-hyperglycemic activity of Insulin plant leaves (Chamaecostuscuspidatus (Nees& Mart.) CD Specht & DW Stev.) and unprocessed Haridrarhizome (Curcuma longa L.). Journal of Indian System of Medicine, 5(3), p.203.

[45]. Bhat, V., Asuti, N., Kamat, A., Sikarwar, M.S. and Patil, M.B., 2010. Antidiabetic activity of insulin plant (Costusigneus) leaf extract in diabetic rats. Journal of Pharmacy Research, 3(3), pp.608-611.

[46]. Panagal, M., Kumar, R.A., Bastin, T.J., Jenifer, S. and Muthuvel, A., 2010. Comparative evaluation of extracts of C. igneus (or C. pictus) for hypoglycemic and hypolipidemic activity in alloxan diabetic

rats. International Journal of Pharmacy and Technology, 2(1), pp.183-195.

[47]. SAMUEL, G., PRABU, H., JOHNSON, I. and JOY, I.W., 2012. EFFECT OF CHAMAECOSTUS CSPIDATUS EXTRACT ON SUGAR SOLUTION-A ULTRASONIC TECHNIQUE.

[48]. Shinde, S., Surwade, S. and Sharma, R., COSTUS IGNUS: INSULIN PLANT AND IT'S PREPARATIONS AS REMEDIAL APPROACH FOR DIABETES MELLITUS.

[49]. NAGALINGAM, M., Rajeshkumar, S. and Lakshmi, T., 2020. Green Synthesis of Gold Nanoparticles Using Different Medicinal Plants and Its Uv-Vis Spectroscopic Analysis and Antibacterial Activity. PLANT CELL BIOTECHNOLOGY AND MOLECULAR BIOLOGY, pp.28-35.

[50]. 50. Thiruchenduran, S., Maheswari, K.U., Prasad, T.N.V.K.V., Rajeswari, B. and Suneetha, W.J., 2017. UV-Vis scanning coupled with PCA as an alternative method for phytochemical screening of natural products â€"CostusIgneus leaf metabolites. Journal of Pharmacognosy and Phytochemistry, 6(1), pp.411-416.

[51]. Nandhini, G., Suriyaprabha, R., Maria Sheela Pauline, W., Rajendran, V., Aicher, W.K. and Awitor, O.K., 2018. Influence of solvents on the changes in structure, purity, and in vitro characteristics of green-synthesized ZnO nanoparticles from Costusigneus. Applied Nanoscience, 8, pp.1353-1360.

[52]. Sulakshana, G. and Rani, A.S., 2014. HPLC analysis of diosgenin in three species of Costus. Int J Pharm Sci Res, 5(11), pp.747-749.

[53]. Saraswathi, R., Lokesh, U., Venkatakrishnan, R., Meera, R. and Devi, P., 2010. Isolation and biological evaluation of steroid from stem of Costusigneus. Journal of Chemical and Pharmaceutical Research, 2(5), pp.444-448.

[54]. Muthukumar, C., Cathrine, L. and Gurupriya, S., 2019. Qualitative and quantitative phytochemical analysis of Costusigenus leaf extract. Journal of Pharmacognosy and Phytochemistry, 8(4), pp.1595-1598.

[55]. THIRUCHENDURAN, S., EXTRACTION EVALUATION AND APPLICATION OF BIOACTIVE COMPOUNDS FROM Costusigneus LEAF.

[56]. Josephine, I.G. and Punnagai, K., 2019. In Vitro Cytotoxicity Activity of Ethanolic Leaf Extract of CostusIgneus Against Hepatocellular Carcinoma (HepG2) Cells. Biomedical and Pharmacology Journal, 12(2), pp.901-906.

[57]. Saneja, A., Sharma, C., Aneja, K.R. and Pahwa, R., 2010. Gymnemasylvestre (Gurmar): A review. Der Pharmacia Lettre, 2(1), pp.275-284.

[58]. Kanetkar, P., Singhal, R. and Kamat, M., 2007. Gymnemasylvestre: a memoir. Journal of clinical biochemistry and nutrition, 41(2), pp.77-81.

[59]. Tiwari, P., Mishra, B.N. and Sangwan, N.S., 2014. Phytochemical and pharmacological properties of Gymnemasylvestre: an important medicinal plant. BioMed research international, 2014.

[60]. Shanmugasundaram, E.R.B., Rajeswari, G., Baskaran, K., Kumar, B.R., Shanmugasundaram, K.R. and Ahmath, B.K., 1990. Use of Gymnemasylvestre leaf extract in the control of blood glucose in insulin-dependent diabetes mellitus. Journal of ethnopharmacology, 30(3), pp.281-294.

[61]. LIU, H.M., Kiuchi, F. and TsUDA, Y., 1992. Isolation and structure elucidation of gymnemic acids, antisweet principles of Gymnemasylvestre. Chemical and Pharmaceutical Bulletin, 40(6), pp.1366-1375.

[62]. Persaud, S.J., Al-Majed, H., Raman, A. and Jones, P.M., 1999. Gymnemasylvestre stimulates insulin release in vitro by increased membrane permeability. Journal of endocrinology, 163(2), pp.207-212.

[63]. Baskaran, K., Ahamath, B.K., Shanmugasundaram, K.R. and Shanmugasundaram, E.R.B., 1990. Antidiabetic effect of a leaf extract from Gymnemasylvestre in non-insulin-dependent diabetes mellitus patients. Journal of ethnopharmacology, 30(3), pp.295-305.

[64]. Sahu, N.P., Mahato, S.B., Sarkar, S.K. and Poddar, G., 1996. Triterpenoidsaponins

from Gymnemasylvestre. Phytochemistry, 41(4), pp.1181-1185.

[65]. Singh, V.K., Umar, S., Ansari, S.A. and Iqbal, M., 2008. Gymnemasylvestre for diabetics. Journal of herbs, spices & medicinal plants, 14(1-2), pp.88-106.

[66]. Pothuraju, R., Sharma, R.K., Chagalamarri, J., Jangra, S. and Kumar Kavadi, P., 2014. A systematic review of Gymnemasylvestre in obesity and diabetes management. Journal of the Science of Food and Agriculture, 94(5), pp.834-840.

[67]. Khan, F., Sarker, M.M.R., Ming, L.C., Mohamed, I.N., Zhao, C., Sheikh, B.Y., Tsong, H.F. and Rashid, M.A., 2019. Comprehensive review on phytochemicals, pharmacological and clinical potentials of Gymnemasylvestre. Frontiers in pharmacology, 10, p.1223.

[68]. Chattopadhyay, R.R., 1998. Possible mechanism of antihyperglycemic effect of Gymnemasylvestre leaf extract, part I. General Pharmacology: The Vascular System, 31(3), pp.495-496.

[69]. Shanmugasundaram, E.R.B., Gopinath, K.L., Shanmugasundaram, K.R. and Rajendran, V.M., 1990. Possible regeneration of the islets of Langerhans in streptozotocin-diabetic rats given Gymnemasylvestre leaf extracts. Journal of ethnopharmacology, 30(3), pp.265-279.

[70]. El Shafey, A.A., El-Ezabi, M.M., Seliem, M.M., Ouda, H.H. and Ibrahim, D.S., 2013. Effect of Gymnemasylvestre R. Br. leaves extract on certain physiological parameters of diabetic rats. Journal of King Saud University-Science, 25(2), pp.135-141.

[71]. Ayyanar, M. and Subash-Babu, P., 2012. Syzygiumcumini (L.) Skeels: A review of its phytochemical constituents and traditional uses. Asian Pacific journal of tropical biomedicine, 2(3), pp.240-246.

[72]. Srivastava, S. and Chandra, D., 2013. Pharmacological potentials of Syzygiumcumini: a review. Journal of the Science of Food and Agriculture, 93(9), pp.2084-2093.

[73]. Kumar, A., Ilavarasan, R., Jayachandran, T., Decaraman, M., Aravindhan, P., Padmanabhan, N. and Krishnan, M.R.V., 2009. Phytochemicals investigation on a tropical plant, Syzygiumcumini from Kattuppalayam, Erode district, Tamil Nadu, South India. Pakistan Journal of Nutrition, 8(1), pp.83-85.

[74]. Chhikara, N., Kaur, R., Jaglan, S., Sharma, P., Gat, Y. and Panghal, A., 2018. Bioactive compounds and pharmacological and food applications of Syzygiumcumini–a review. Food & function, 9(12), pp.6096-6115.

[75]. Bhatia, I.S. and Bajaj, K.L., 1975. Chemical constituents of the seeds and bark of Syzygiumcumini. Planta Medica, 28(08), pp.346-352.

[76]. Karthic, K., Kirthiram, K.S., Sadasivam, S., Thayumanavan, B. and Palvannan, T., 2008. Identification of amylase inhibitors from Syzygiumcumini Linn seeds.

[77]. Venkateswarlu, S., Kumar, B.N., Prasad, C.H., Venkateswarlu, P. and Jyothi, N.V.V., 2014. Bio-inspired green synthesis of Fe3O4 spherical magnetic nanoparticles using Syzygiumcumini seed extract. Physica B: Condensed Matter, 449, pp.67-71.

[78]. Raza, A., Butt, M.S. and Suleria, H.A.R., 2017. Jamun (Syzygiumcumini) seed and fruit extract attenuate hyperglycemia in diabetic rats. Asian Pacific journal of tropical biomedicine, 7(8), pp.750-754.

[79]. Prabakaran, K. and Shanmugavel, G., 2017. Antidiabetic activity and phytochemical constituents of Syzygiumcumini seeds in Puducherry region, South India. Int J PharmacognPhytochem Res, 9(7), pp.985-89.

[80]. Singh, N. and Gupta, M., 2007. Effects of ethanolic extract of Syzygiumcumini (Linn) seed powder on pancreatic islets of alloxan diabetic rats.