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A SCIENTIFIC REVIEW ON Anacardiumo ccidentale GUM

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ABSTRACT :

Plant gums are generally complex carbohydrate polymers that may also include hydroxyproline-rich proteins, resins, or other components and can be soluble, partly soluble, or insoluble.Because of their co-occurrence with other secretion types and material properties, gums have been at times confused with resins (especially from leguminous spp.) or latexes. Cashew Gum is a bark exudate from *Anacardium occidentale L.* belonging to the family Anacardiaceae, a tree that can grow up to10m tall. Even though, it is widely grown in many tropical and subtropical countries, the cashew tree is nativeto north-eastern Brazil, which has around 600,000 plantations. However, it can also be found in India, Mozambique, Tanzania, and Kenya among other countries. In the present review the pharmacological and pharmaceutical application of cashew nut have been discussed.

INTRODUCTION

Gum is a sap or other resinous material associated with certain species of the plant kingdom. This material is often polysaccharide-based and is most frequently associated with woody plants, particularly under the bark or as a seed coating. Gums and gum resins of wood and bark are produced by duct structures that have close morphological similarities to resin-producing ducts[1]. Gum-secreting epithelial cells also line the gum ducts, with their Golgi bodies being the site of (carbohydrate) synthesis, transport, and secretion. Gum ducts may be formed either constitutively or in response to injury, the latter being referred to as 'gummosis. The gum secretions are, however, complex and variable between species, but often also contain terpenoids and significant levels of other carbohydrate components (especially starch).Many herbaceous and woody plants produce gums, only a few tree species produce commercial quality and quantities of gums, these currently being limited to families of the Fabaceae, Sterculiaceae, and Combretaceae, with the Fabaceae being the most important[2].

Studies were performed on the cashew gum for its gelling property. The gels prepared with 5.0% of mucilage were found to be ideal and comparable with a commercial preparation. The prepared gels did not produce any dermatological reactions. The cashew gum was also studied for its binding property[3]. The disintegration time of a tablet increases with increaser in the concentration of cashew gum. Gummosis or gumming syndrome is the release of gum in response to injury and poses a serious problem in either fruit and/or wood of commercially important fruit tree species, such as citrus crops and *Prunus* spp. (e.g., cherry, plum, peach, and apricots) . This can include loss of fruit, loss of high-quality wood (i.e., black cherry, *Prunus serotina*), and even tree death. Infected citrus saplings, for example, can also form gum ducts with the cambium zone, depositing gum into young vessels and hampering the water conduit system of the tree[4].

Gum, in botany, adhesive substance of vegetable origin, mostly obtained as exudate from the bark of trees or shrubs belonging to the family Fabaceae (Leguminosae) of the pea order Fabales. Some plant gums are used in the form of water solutions in the manufacture of cosmetics, pharmaceuticals, and foods. When the water evaporates, a film having a considerable adhesive character is formed. Some plant gums, such as gum arabic, dissolve in water to give clear solutions[4]. Other gums, such as gum tragacanth, form mucilages by the absorption of large amounts of water.

Industrial gums, which for the most part are water-soluble polysaccharides, have enormously large and broad application in both food and non-food industries. All applications depend on the properties provided by very large molecules in various states of hydration, but mostly depend on the properties they impart to solutions and gels. Polysaccharides are used in the food industry because they are widely available, usually of low cost, and nontoxic. Their use in non-food applications depends on unique special properties they provide, often at costs below those of synthetic polymers.

Gums commonly used in foods are starches, cellulose derivatives, guar gum, locust bean gum, pectin, algin, carrageenan, xanthan, and gum arabic, and to a much lesser extent agar and gums ghatti, karaya, and tragacanth. New gums are continually being examined for commercial introduction to provide broader uses[5]. Gums likely to be introduced are the hemicelluloses such as the hemicellulose from corn fiber, derived from the seed coat of corn grain during wet milling for starch production.

Industrialists giving thought to the manufacture of a gum or to the use of a gum in their products will give serious consideration to the numerous factors that affect their selection. Among these factors are [6]

(1) Physical and chemical properties required

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(2) Gum cost
(3) Constancy of cost, particularly if world labor rates continue to rise
(4) Constancy of supply and composition and
(5) Possibility of eventual replacement of the selected gum by another.

In practical terms, gums are either hydrophobic or hydrophilic high molecular-weight molecules, usually with colloidal properties, that in an appropriate solvent or swelling agent produce gels or highly viscous suspensions or solutions at low dry substance content[7]. Thus, the term gum is applied to a wide variety of substances with "gummy" characteristics and cannot be precisely defined. Hydrophobic substances often called gums are high-molecular-weight hydrocarbons and other petroleum products, rubbers, certain synthetic polymers, chicle for chewing gum, and the resinous saps that often exude from evergreens and that are sometimes commercially tapped to obtain, for example, gum balsam and gum resin[8]. Incense gums, such as myrrh, huataco, and frankincense, are fragrant plant exudates that are mixtures of resins and carbohydrates and are gummy because of their content of hydrophobic resin.

Certain gums dissolve in water to form a transparent colloidal solution (e.g. Gum Arabic). Gums such as gum tragacanth, gum karaya do not dissolve in water but swell up into a jellylike mass. However, if sufficient amount of water is added they yield a thick transparent solution[9]. Partially soluble gums first form a swollen jelly by dispersing in water and become solution on addition of more water. Gum resins are a combination of resins and true gums with a mixture of characteristics of both. Certain gum resins contain small amount of essential oil they are called oleo-gum resins. Small quantities of resins exude on the surface of the trunk due to injury by wind, fire, lightening or wound caused by animals.

The plants based polymers have been studied for their application in different pharmaceutical dosage forms like matrix controlled system, film coating agents, buccal films, microspheres, nanoparticles, viscous liquid formulations like ophthalmic solutions, suspensions, implants and their applicability and efficacy has been proven[10]. These have also been utilized as viscosity enhancers, stabilisers, disintegrants, solubilisers, emulsifiers, suspending agents, gelling agents, bioadhesives & binders.

The tree is well known for its nuts that are used as a food ingredient, especially in oriental delicacies. Cashewtree resin is synthesized in the epithelial cells lining pockets or canals and thensecreted into these internal cavities. Synthesis generally occurs in all organs of the plant, with different quantitative composition; appearing to be genetically controlled and little influenced by environmental conditions[11]. Due to its insecticidal and good adhesive properties, the gum finds extensive application in book binding.

But on contrary Cashew tree is prone to infestations due to *Analeptes trifasciata*, which is an increasing threat to cashew cultivation in Nigeria [16-18]. An electrophoretically pure acidic polysaccharide with M.W. 6.412 x 10^4 has been isolated from this gum. The whole gum is a low viscosity polysaccharide with an activation energy of flow for solution at 2 and 3% ($\tilde{1}$ 6 kJ mol^{-1}), characteristic of systems with little intra and intermolecularinteractions.

Chemical Structure:-

Its structure has been elucidated by various techniques such as immunochemical reactions, hydrolysis underdifferent conditions, methylation, periodate oxidation studies and cross reactions with different anti-sera. The polysaccharides chains of Cashew Gum contain are arabinogalactans with a variety of side chains, including glucuronic and galacturonic acid residues[12]. Cashew Gum was subjected to partial and complete hydrolysis to trace out its constituents.

Composition:-

The Cashew Gum occurs in the form of pale yellow to reddish stalactic masses. Notably, these acid polysaccharides also contain various metal ions in the form of neutralized cations. The nature and content of these constituents depend on the composition of the soil upon which the trees grows. The major cations traced are K+, Na+, Ca2+ and Mg2+.

These cations have impacts on the viscosity. Presence of salts like NaCl, CaCl2 and AlCl3 reduces the viscosity. The affinity between Cashew Gum and metal ions follows the order: Al3+ > Ca2+ > Na+.

The crude Cashew Gum containing these cations tends to be naturally transformed into Na salt, after purification or dialysis against NaCl 0.15 M. Botanical studies suggested that in cold water, it swells into a jelly like mass but dissolves rapidly when heated[13]. Cashew Gum possibly has polyanionic charges due to the presence of glucuronic acid.

EXTRACTION:-

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It is a polysaccharide that is obtained through the exudates. Indeed, the cashew exudates are obtained after mechanical injury of the plant by incision of the bark. Cashew gum is one such versatile naturally occurring biopolymer that is finding increasing applications in the pharmaceutical and biotechnology industry.Generally, hot-water treatment has been used for extraction of hydrocolloid gums. Several studies are reported on various gums and the extracting conditions which give the optimal yield varied from one plant species to another. Otherwise, hydrocolloids extraction process is influenced by a number of variables, such as extraction temperature, solvent to solid ratio, solvent pH, extraction time, particle size, etc[14]. For the crude gum extraction from A. occidentale exudates, showed that the extracting temperature, agitation speed, water to exudates ratio and the extracting time factors were found to be significant in the aqueous extraction process. Therefore, it is important to find the optimum level for each factor in order to obtain the highest yield of crude cashew gum.

PURIFICATION:-

CG contains divalent metal ions with the rank order: Ca2+> Mg2+ > Fe2+ > Zn2+, and trace amounts (< 0. 1mg/kg) of the monovalent ions K+ and Na+. The amount of each of the metal ions in CCG (crude cashew gum) was higher than in PCG (Purified cashew gum). The pH of CCG or PCG mucilage was more stable when refrigerated than on storage at 25°C and 50°C. The pH of PCG mucilage was less stable than CCG on storage[15]. The viscosity of PCG increased with increase in the gum concentration and decreased with increase in temperature. Therefore to attain the desired intrinsic properties, purification was crude Cashew Gum becomes all the more essential.

Cleaning of crude cashew gum is effected byremoving the bark and other extraneous materials by hand picking, breaking and sieving. The gum was dried in an oven at 56°C for about 8 h until it became sufficiently brittle. The dried gum was then sorted into two grades, light colored grade and dark colored grade. The light colored grade was selected and milled in a domestic blender into fine powder[16]. To purify the gum 100 g of the crude gum powder was dissolved in 200 ml of distilled water and allowed to stand for 24 h with intermittent stirring as the gum was very soluble in water.

The solution was filtered using a piece of calico to remove any insoluble debris or impurities. The filtered mucilage was re-filtered to ensure that all debris was removed. The filtered mucilage was purified by precipitating the gum out with 96% ethanol. About 350 ml of 96% ethanol was used to precipitate 100 g of the gum, the precipitated gum was filtered and washed with 96% ethanol and washed with di- ethyl ether and dried in the hot air oven at 50°C for about 8 h and sieved through sieve number 80[17].

PHYSIOCHEMICAL PROPERTIES:-

The physiochemical properties of Cashew Gum depend upon its source and age of the tree. Investigations showed that properties like viscosity along with comparison with gum Arabic. At a concentration of 80% Cashew Gum showed gelling property due to enhanced interactions of binding forces.

Viscosity which is the measure of thickness of gums is used in the determination of quality of gums. Higher the viscosity better is the quality of the gum. The average viscosity of 1% Cashew Gum at 25°C was foundto be 10.03 cPs compared to 5 cPs of gum Arabic (AR), thus making Cashew Gum a better thickening or stabilizing agent[18]. Viscosities of Cashew Gum produced by mature trees in the different locations were found to be higher than that produced by young trees and this may be attributed to the differences in the molecular structure and the pH. Due to the high viscosity of Cashew Gum, its utilization in food products should be encouraged.

Viscosity of Cashew Gum is also affected by change in temperature which is due to the change in thermal decomposition of CG during heating[19]. However, the mechanism of thermal decomposition of CG is unknown. Studies on solubility of dissolved fractions of CG (64.2%) dissolved in water at 30°C which was further increased to13.4%. The fraction that dissolved at 30°C produced greater solution viscosity than the other fraction or the whole gum. When the pH was raised above 5.5, the solution viscosity dropped sharply.

Apart from viscosity, swelling behavior of CG as a function of pH and presence of salt has also been investigated using different ratios of chitosan/cashew nut gum (CH/CG). Swelling in water diminishes sharply when the ratio CH/CG increases. In the presence of Na+ the degree of swelling (Q) remains fairly constant, whereas in presence of Ca2+ Q increases with the CH/CG ratio. It was found that swelling is maximal at pH 2 and at pH 10, where the gel can absorb water up to 44 times its own weight. The amine group of chitosan and the carboxylate groups of Cashew Gum seems to play a major role in the swelling mechanism.

Adsorption property of Cashew Gum has also been studied. Presence of galactose units in Cashew Gum makes them a possible adsorbate onto the silicon wafers and amino- terminated surface which was

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investigated by means of ellipsometry, atomic force microscopy (AFM) and contact angle measurements. It was confirmed that pH has a strong influence on the adsorption behavior. At pH values lower than 4 amino-terminated surfaces are positively charged and CG behaves as a polyanion (due to the glucuronic acid units along its chain).

PHARMACOLOGICAL APPLICATIONS

Antitumor Activity -

Cashew Gum exhibited high inhibitory activity against an implanted sarcoma 180 solid tumour in mice, characterizing an antitumor activity of the Cashew Gum and can be used for the prevention of cancer, and/or as an adjuvant with cancer chemotherapy drugs, after the removal of a malignant tumour[20].

Hypoglycaemic Property -

CG shows hypoglycaemic effect in normal (normoglycaemic) and in streptozotocin-treated diabetic wistar rats. Methanolic and aqueous extracts of CG (100-800 mg/kg p.o.) were compared with those of insulin (5 micro/kg s.c.) and glibenclamide (0.2 mg/kg p.o.) in both fasted normal and fasted diabetic rats. CG extracts produced dose-dependent, significant reductions in the blood glucose concentrations of both fasted normal and fasted diabetic rats. Although, aqueous or methanolic extract is less potent than insulin as an antidiabetic agent, the results of this experimental animal study indicate that it possesses hypoglycaemic activity, and thus lends credence to the folkloric use of the plant in the management and/or control of adult-onset, type-2 diabetes mellitus among the Yoruba- speaking people of Western Nigeria.

Antimicrobial Evaluation of Cashew Gum -

The antimicrobial activity of crude and purified Cashew Gum against bacteria, yeast and fungi, was evaluated as a carbon source for microbial growth. Cashew gum presented only a weak activity against Saccharomyces cerevisiae and no activity was observed against all other microorganisms tested. The possibility that removal of anacardic acid present in the raw gum during purification may explain the negative results obtained[21]. When purified CG was used as carbon source, only Listeria monocytogenes, Saccharomyces cerevisiae and Kluyveromyces marxianus did not grow after 5 days of incubation. However, it was not possible to identify if this behaviour was due to gum adhesion to the cell walls or due to the polysaccharide use as a carbon source by the microorganism. The only antimicrobial effects of cashew gum were observed against S. cerevisiae. However, the presence of 2000 g/ml of cashew tree gum in medium produced only 53% growth inhibition.

PHARMACEUTICAL APPLICATIONS: -

Cashew Gum extraction can represent one more source of revenue for the producer, in addition to the nut. Therefore, there is the need to study the physicochemical properties of cashew gum. Cashew Gum has gained lot of attention in the past few years as is seen from the recent literature. The unique properties of this polysaccharide are due to its characteristic glycosidic linking. Cashew Gum is easily chemically modified to reduce the water solubility or to develop pH sensitivity, introduce functional reactive groups etc. So that it can be utilized for a chosen application[22]. In this review we summarize the intensive work of last one decade using Cashew Gum as a wonder excipient.

Binders -

The properties of Cashew Gum have also been exploited as a binder. The binding efficacy of Cashew Gum in tablet formulation in comparison with standard binders such as acacia and polyvinyl pyrrolidone (PVP K-30) suggested it to be better binding agent.

Gelling Agent -

Cashew Gum as gelling agent have been explored. Generally gels prepared with 5.0% of mucilage were found to be ideal, comparable with a commercial preparation and safer during skin toxicity studies. Cashew Gum interacts with water and it has emulsifier, adhesive and stabilizer properties Botanical studies suggested that in cold water, it swells into a jelly like mass but dissolves rapidly when heated. The crude gum when chemically treated, gives a kind of gel called microbiofilm[23]. Realisation of the above mentioned properties later culminated in characterizing chitosan/cashew gum (CH/CG) gel for the controlled release system.

Superadsorbent Hydrogels-

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Superabsorbent hydrogels based on methacrylated cashew gum (CGMA) were co-polymerized with acrylamide(AAm) [46] by measuring morphological and mechanical properties. Hydrolyzed CGMA-co-AAm hydrogels showed highly water absorbing. Another remarkably feature of these hydrogels is the efficiency of water retaining that was caused by increasing in CGMA content. Higher temperature leads to an enhancement in the stress values of superabsorbenthydrogels because the large content of water that penetratesinto superabsorbent hydrogels and expands the polymer network.

Sustained Release Tablets-

Fabrication of sustained release systems utilizing CG and its modifications have been an area of great interest. Studies regarding the formulation of such system using CG, HPMC and Carbopol and its preformulation studies have been worked upon. The tablet with HPMC(20% w/w) and Carbopol (20% w/w) exhibited greater drug content than those with CG and other batches of HPMC and carbopol (30% w/w and 40% w/w) at a pH 7.4. A better sustained drug release (50.65%) was obtained with the matrix tablet (40% w/w) made-up of the carbopol than with the CG and HPMC. The dissolution profile using different polymers, justified scientifically that an increase in the polymer ratio, retarded the drug release to a greater extent[24]. It was also concluded that the formulated matrix tablets using natural polymer CG, HPMC and Carbopol were capable of exhibiting sustained release properties.

Surfactants

Effects of concentrations and interactions of CG and Tween 80 and its influence on apples surface properties, on the coating/film's wettability, water vapour permeability, opacity and mechanical properties was evaluated using a 22 factorial design. The addition of blends of theses surfactant (CG and Tween 80) reduced the cohesion forces, therefore reducing the surface tension and increasing the wettability; this resulted in an improved compatibility between the solution and the fruit skin surface [25]. The opacity was also reduced. Applications of these coatings/films on foods for the improvement of fruits storage conditions have major implications.

Drying Aid Agent

Attempts were made to totally or partially replace maltodextrin DE10 (MD10) by CG as a drying aid agent in spray drying of cashew apple juice. Increasing the proportion of drying aid, cashew apple not only resulted in improved physical properties of the powder (decreased its hygroscopicity and increased flowability), but also enhanced ascorbic acid retention (AAR) during the process. CG was shown as a promising maltodextrin replacer, being more eective than the latter to decrease powder hygroscopicity. The drying aid/cashew apple juice in the dry weight ratio of 5:1 gave best results. Additionally 90% of ascorbic acid was preserved during spray drying which was not true when MD10 was used.

Cashew gum as Coating Agent:

Cashew gum was assessed as a coating agent in the production of chocolate pebbles, using gum from both young and mature cashew trees. Pebbles produced with CG samples were compared or produced with gum Arabic.

Oral thin films-

In preparation of cashew gum-based free films cashew gum-based free films were prepared by the solvent casting method.For each formulation, the required amount of the polymer material (cashew gum alone, or cashew gum and CMC or HPMC) was weighed into a beaker and 15 ml of distilled water added. The mixture was stirred with a stirrer, plasticized with the required amount of glycerol or propylene glycol and then stirred again with a magnetic stirrer for 2 h. The solution was made up to the final volume (20 ml) with distilled water and then left to stand overnight to enhance dissolution and to remove any trapped air bubbles[26]. The mixture was then stirred again for 1 h. The 20 ml formulation was then carefully poured into the centre of a 9 cm diameter plastic Petri dish and then left to dry in an oven at 60 °C . The drying times of the films varied from 4 to 6 h. The films were then carefully removed and placed in labeled Petri dishes.

Antimicrobial activity of gum

Purified and crude cashew gum was prepared separately in distilled water and the antimicrobial activity determined against E.coli,Staph.aureus,Candida albicans, Klebsiella, and Pseudomonas aeruginosa using the cup plate method. The plates were observed for any zones of inhibition after incubation for 48 hours. The microbial quality of crude and purified cashew gum[22]. The microbial quality of the gums was assessed to determine their acceptability for use as pharmaceutical excipients in oral formulations. The total viable aerobic count and fungal count of the purified cashew gum was lower than that of the crude gum. Both the crude

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and purified forms of the gum did not contain E. coli, Pseudomonas aeruginosa or pathogenic Staphylococci. The microbial quality of the purified cashew gum was satisfactory[23].

Stabilization of emulsions-

Paraffin oil emulsions containing 20 % w/v cashew gum were prepared using the wet gum method. One hundred milliliters (100ml) of paraffin oil emulsion was transferred into a domestic blender and homogenized for 3 minutes. Stabilization of 100 ml paraffin oil emulsions was further attempted by addition of a thickening agent (xanthan gum: 40 ml, 0.025 – 0.5 % w/v) and a surfactant (Tween80: 15 ml, 0.0025 - 0.05 % v/v) followed in each case by homogenization in a domestic blender for 3 min. The emulsions were transferred into plain bottles, covered and stored at room temperature for observation.

Suspending agent :

The suspending potential of cashew gum was investigated by incorporating different amounts of the gum in zinc oxide suspensions. The suspending property of cashew gum was compared to that of xanthan gum, a standard suspending agent for peroral preparations. Zinc oxide powder (sifted through sieve 0.177 mm and levigated with glycerine) was used to prepare suspensions containing 0.1, 0.2, 0.3, 0.4, 0.5, 1.0, 2.0, 3.0 and 4.0 % w/v cashew gum and 0.1, 0.2, 0.3, 0.4 and 0.5 % w/v xanthan gum. All the suspensions were preserved with 0.2 % sodium benzoate.

CONCLUSION

Natural gums as mentioned above are used widely in most of the formulations because their ssavailability. They are economically cheaper than the industrial gums. Natural gums or plant gums are complex carbohydrate polymers and also consists of components like resins which are soluble, partly soluble, or insoluble. Some of the natural gums like Abelmuschus, Almond, and Neem gum are used as suspending agent, disintegrating agent, emulsifier, binder etc in the pharmaceutical preparations. Here we have concentrated on cashew gum which is widely used in industries as it has many benefits in the pharmaceutical formulations. Cashew gum is mainly used as binder, gelling agent, coating agent, surfactant in the industries.Cashew gum has the pharmacological activities like Antitumor activity, Hypoglycemic,Antimicrobial activity. And it is also available economically.

REFERENCES

1. Raymond CR, Paul JS, Siân CO. (Ed.), Handbook of Pharmaceutical Excipients. 5th ed. London (UK): The Pharmaceutical Press; 2006.
2. Davision RL. Handbook of watersoluble gums and resins. New York, McGraw Hill Book company; 1980.
3. Ravi Kumar, M. B. Patil, Sachin R. Patil, Mahesh S. Evaluation of Abelmoschus Esculentus Mucilage as Suspending Agent in Paracetamol Suspension. International Journal of PharmTech Research2009; 1(3): 658 665.
4. S. Sarojini, Deepthi S. Kunam , R. Manavalan and B. Jayanthi .Effect of natural gum as a binder in the formulation of diclofenac sodium tablets.International journal of pharmaceutical sciences and research (2010);1(3):5560
5. Vazquez B, Avila G, Segura D, Escalante B. Antiinflammatory activity of extracts from Aloe vera gel. J Ethnopharmacol 1996;55:6975.
6. Rao PS and Srivastava HC., Tamarind in industrial gums. In: Whistler RL. 2 nd ed., Academic Press, New York 1973; 369411.
7. The wealth of India, first supplement series, volume 3: SiTy, New Delhi, Dr K S Krishna Marg; National institute of science communication, CSIR 1999: 89137.
8. Üner M, Altinkurt T. Evaluation of honey locust (Gleditsia triacanthos Linn.) gum as sustaining material in tablet dosage forms. Il Farmaco 2004;59(7):56773.
9. Smith F, Montogomery R. The chemistry of plant gums and mucilages and some related polysaccharides. New York: Reinhold Publishing Corp; 1959.
10. Gyedu-Akoto E, Oduro I, Amoah FM, Oldham JH, Ellis WO, Opoku-Ameyaw K, Bin Hakeem R. Physicochemical properties of cashew tree gum. African Journal of Food Science 2008; 2: 060 – 064.
11. R. Kumar, M.B. Patil, S.R. Patil, M.S. Paschapur, Int. J. PharmTech Res. 1 (2009) 695–704.
12. raruna, F. B., Quelemes, P. V., de Faria, B. E. F., Kuckelhaus, S. A. S., Marangoni, V. S., Zucolotto, V., et al. (2013). Green synthesis and characterization of silver nanoparticles reduced and stabilized by cashew tree gum. Advanced Science, Engineering and Medicine, 5(8), 890–893.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

13. Aghbashlo, M., Mobli, H., Madadlou, A., & Rafiee, S. (2012). The correlation of wall material composition with flow characteristics and encapsulation behavior of fish oil emulsion. Food Research International, 49, 379–388.
14. Anwar, S. H., & Kunz, B. (2011). The influence of drying methods on the stabilization of fish oil microcapsules: comparison of spray granulation, spray drying, and freeze drying. Journal of Food Engineering, 105, p. 367-378.
15. Dickinson, E. (2003). Hydrocolloids at interfaces and the influence on the properties of dispersed systems. Food Hydrocolloids
16. .McChesney JD, Venkataraman SK, Henri JT. Plant natural products: Back to the future or into extinction, Phytochemistry 2007; 68: 2015-22.
17. Guo J, Skinner GW, Harcum WW, Barnum PE. Pharmaceutical applications of naturally occurring water-soluble polymers. PSTT 1998; 1: 254-61.
18. Chivate AA, Poddar SS, Abdul S, Savant G. Evaluation of Sterculiafoetida gum as controlled release excipient. AAPS PharmSciTech 2008; 9: 197-204.
19. Varshosaz J, Tavakoli N, Eram SA. Use of natural gums and cellulose derivatives in production of sustained release Metoprolol tablets. Drug Deliv 2006; 13: 113-19.
20. Malafaya PB, Silva GA, Reis RL. Natural-origin polymers as carriers and scaffolds for biomolecules and cell delivery in tissue engineering applications. Adv Drug Deliv Rev 2007; 59: 207-33.
21. Cunha PLR, Maciel JS, Sierakowski MR, De Paula RCM, Feitosa JPA. Oxidation of cashew tree gum exudates polysaccharide with TEMPO reagent. J BrazChemSoc 2007; 18(1): 85-92.
22. Torquato DS, Ferreira ML, Sa GC, Brito ES, Pinto GAS, Azevedo EHF. Evaluation of antimicrobial activity of cashew tree gum. World J Microbiol&Biotechnol 2004; 20: 505-07.
23. Pandey R, Khuller GK. Polymer based drug delivery systems for mycobacterial infections. Curr Drug Deliv 2004; 1: 195-201.
24. Chamarthy SP, Pinal R. Plasticizer concentration and the performance of a diffusion-controlled polymeric drug delivery system. Colloids Surf A PhysiochemEng Asp 2008; 331: 25-30.
25. Alonso-Sande M, Teijeiro OD, Remunan-Lopez C, Alonso MJ. Glucomannan, a promising polysaccharide for biopharmaceutical purposes. Eur J Pharm Biopharm 2008; 72(2): 453-62.
26. Freire FCO, Cardoso JE, dos Santos AA, Viana FMP. Diseases of cashew nut plants (Anacardium occidentale L.) in Brazil. Crop Protection 2002; 21(6): 489-94.