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OVERVIEW: PHYTOTHERAPY BY *BOSWELLIA SERRATA* AS A CANCER FIGHTER

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Keywords:

Boswellia serrata, Cancer, Herbal medicine, Boswellic acid, AKBA, Pharmacological action.

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ABSTRACT: The *Boswellia serrata* word frankincense is derived from the Old French word frauk-encens and it means the true, authentic, pure, or "free lighting" incense. The specific name, serrata, comes from serra (a saw), referring to the toothed leaf margins. It belongs to family Burseraceae. This precious plant is mainly popular in dry mountainous regions of India, Northern Africa and Middle East. It mainly used as an herbal medicine for Brain damage, osteoarthritis, rheumatoid arthritis, joint discomfort, bursitis (inflammation of the fluid-filled pads in the joints), and tendons swelling (tendonitis). Nowadays research also made that *Boswellia serrata is* used for cancer treatment as an anti-neoplastic agent. As it is used for breast cancer, pancreatic tumours etc. This review article provides information about phytotherapy by *Boswellia serrata* on cancer and its Pharmacognostic study in brief. Also have collective information about its essential chemical constituents like *Boswellic* acid, Pentacyclic triterpenes, β-boswellic acid, acetyl-β-boswellic acid, 11-keto-β-boswellic acid and acetyl-11-keto-β-boswellic acid. Here we reviewed all Pharmacognostic properties like Morphology, Cultivation, Collection Harvesting Identification and Extraction of phytoconstituents, Herbal formulation in tablet dosage form, endophytes, adulteration, *etc.*

INTRODUCTION: Phytotherapy is a branch of medicine that employs the use of plants to cure or prevent disease. In Western medicine, it's referred to as herbalism. Phytotherapies have traditionally been employed to maintain the original composition and integrity of the parent plant, with the complete plant or a desired percentage of its slightly contaminated components being utilized for therapeutic purposes. Plant-based treatments are used in anthroposophic medicine, naturopathic medicine, traditional Chinese medicine, Ayurvedic medicine, and allopathic medicine, among other medical systems [9] *Boswellia Serrata*. The name frankincense comes from the Old French word frauk-encens, which meaning "genuine, authentic, pure," or "free burning" incense in *Boswellia serrata*. Since ancient times, herbal medicine has been produced mostly on an individual-patient basis, with standardization procedures relying heavily on the physician's opinion.

However, in modern times, the situation has completely altered, and most herbal medications are now manufactured on a large basis. To prevent medication adulteration and guarantee quality control, specific processes must be followed, beginning with identifying individual medicines and ending with creating the final product.

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The use of pharmacognosy and pharmaceutical chemistry procedures to ensure accurate identification and purity is an unavoidable step in the quality assurance and standardization of any product. *Boswellia* has one of the most powerful anti-cancer compounds found in nature.

Triterpenes, b-Boswellic acid and its equivalents were found in a methanolic extract of the gum resin exudates of *B. serrata Boswellia* (BE) [3]. Cancer is a condition in which some cells in the body grow out of control and spread to other body regions. Cancer may begin nearly anywhere in the billions of cells that make up the human body. Human cells normally expand and multiply (*via* a process known as cell division) to create new cells as needed by the body.

As cells age or get damaged, they die and are replaced by new ones. This ordered process can sometimes break down, resulting in aberrant or damaged cells growing and multiplying when they shouldn't. Tumors, which are masses of tissue, can arise from these cells. Tumors may or may not be malignant (benign) [10].

Hyperplasia occurs when cells inside a tissue proliferate at a higher rate than usual, resulting in an overabundance of cells. Under a microscope, however, the cells and the way the tissue is arranged appear to be normal.

Chronic irritation is one of the reasons or situations that might induce hyperplasia [10]. Dysplasia is a disorder that is more advanced than hyperplasia. There is also a build-up of extra cells in dysplasia. However, the cells appear aberrant, and the tissue's organization has changed. In general, the more aberrant the cells and tissue seem, the more likely cancer will develop. Some dysplasia as require monitoring or treatment, while others do not.

A dysplastic nevus (abnormal mole) that develops on the skin is an example of dysplasia. Although most dysplastic nevi do not develop into melanoma, some do [10]. Carcinoma in situ is a more advanced form of cancer. Although it is frequently referred to as stage 0 cancer, the aberrant cells do not infiltrate adjacent tissue in the same manner as cancer cells. However, because certain carcinomas in situ have the potential to develop into cancer, they are typically treated [10].

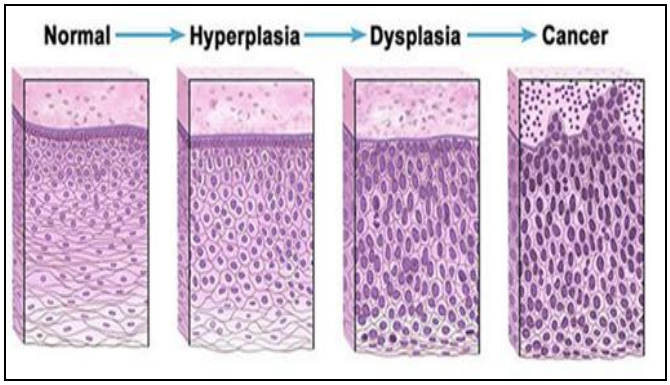


FIG. 1: ORDER OF CANCER CELL FORMATION

History: *Boswellia serrata* is a medium-sized deciduous tree native to central India's arid, hilly regions. *B. serrata* is more properly referred to as Indian frankincense because there are several distinct species of frankincense (*Boswellia* spp.). The term frankincense is most commonly used to refer to *B. carterii*, which is located in southern Arabia. The gum resin of *B. serrate* contains a variety of active ingredients. Palmitic, stearic, oleic, and linoleic acids are found in it. Glucose, arabinose, rhamnose, galactose, fructose, glucuronic acid, and idose are also present. Triterpene alcohol, serratol, and triterpenoids are also found in the gum resin. P-cymene, d-limonene, terpinolene, and bornyl acetates are all present in the volatile oil [4]. Furthermore, *Boswellia* resin has been shown to be effective in the treatment of Alzheimer's disease, the suppression of malignant masses, cardio-vascular health, analgesic, anti-inflammatory, and utilized in the treatment of gastric, hepatic, and skin problems. Coppens (Coppens, 1995). The genus *Boswellia* has around twenty-five species (Al-harrasi *et al.*, 2018). *Boswellia* carteri and *Boswellia serrate* are two species that have been discovered. Some species used for Cancer treatment [1].

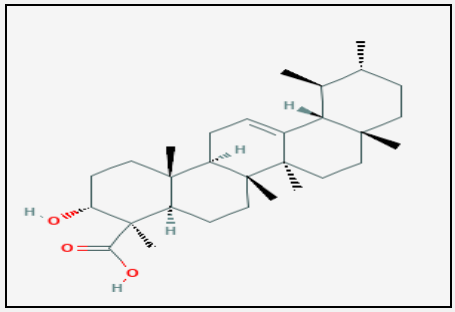
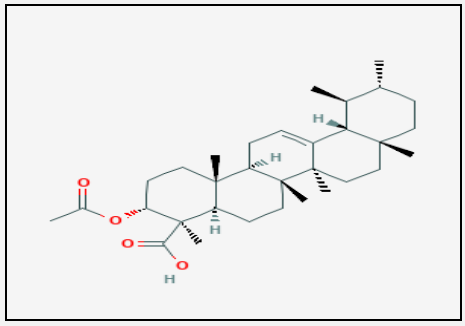
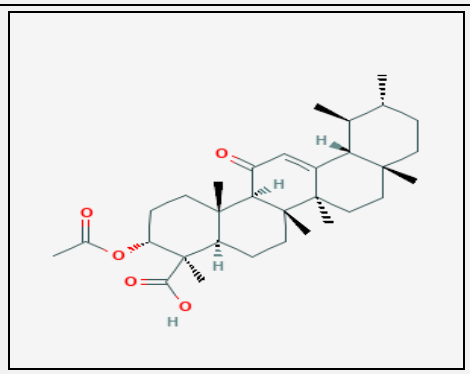
Pharmacognostic Properties:

Synonym: Indian frankincense tree, Indian olibanum, kundru, salai guggul, guggul, salakhi, and in Sanskrit-shallaki, *Boswellia* [3]. Biological source-It is a dried exudate oleo gum resin obtained from branches of plant *Boswellia serrate* belonging to the family *Burseraceae* [3].

Geographical Source: Indian states where it is grown widely include Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Bihar, Orissa and some parts of Western [3].

Chemical Constituents: 8-9 % essential oil, 20-23 % gum, 50 % resin. Pentacyclic triterpenes, *i.e.*, *Boswellic* acids Derivatives like *Boswellia serrate* contains various derivatives of *Boswellic* acid including β-boswellic acid, acetyl-β-boswellic acid, 11-keto-β-boswellic acid and acetyl-11-keto-βboswellic acid [1].

TABLE 1: CHEMICAL CONSTITUENTS *BOSWELLIA SERRATA*

Chemical Constituents	Structure
β-boswellic acid	
acetyl-β-boswellic acid	
acetyl-11-keto-βboswellic acid	

Morphology & Microscopy-3:
Nature: Coarse powder.

Taste: Sub -acrid pungent sweet.

Odour: Sweet balsamic aromatic.

Colour: White yellow.

Leaves: Odd pinnate, Length: 30-45 cm long, ex-stipulate, variable in shape, Crowded at the end of the branches.

Leaflets: 8-15 in number, 2.5-6.3 × 1.2-3.0 cm, ovate or ovate-lanceolate, rounded base, nearly sessile with short toothed, mostly pubescent.

Flowers: Bisexual, small, white in axillary racemes or panicles at the tip of the branches.

Calyx: 5-6 lobed and small copular.

Petals: 0.5-0.8 cm oblong-ovate with basal disk, white pink colour.

Fruits: Cotyledons, trifled, 1.25 cm long, trigonous, obovoid type.

Seeds: Heart-shaped and attached to the inner angle of the fruit, compressed, pendulous.

Microscopy: Appearance Irregular shape, translucent, Brittle irregular droplets or tear-shaped lumps or globes, dusty.

Trichrome: Present.

Sclereides: Present.

Oil Globules: Present-yellow coloured.

FIG. 2: MORPHOLOGY OF *BOSWELLIA SERRATA*

Pharmacological Uses:

- Anti-cancer agent.
- Anti-inflammatory.
- Immunomodulator.
- In Crohn's disease.
- Anti-asthmatic.
- Joint pain anti-arthritic (rheumatoid arthritis, osteoarthritis).

- Analgesic & psychopharmacological activity.
- Muscle relaxant activity.
- Hepatoprotective.
- Hypoglycaemic.
- Autoimmune encephalitis.

Cultivation & Harvesting: Considerations of growing *Boswellia serrata* [4].

Climate and Soil:

- It prefers dry, hot exposures of rocky hills, with 50-125 cm rainfall.
- Usually plant is gregarious, comparatively in open forests.
- In central and peninsular India.
- It occupies the hotter slopes and ridges.
- In its natural habitat, the maximum shade temperature varies from 38-49 °C, the minimum from 1 to 7 °C, and the normal rainfall ranges from 50-125 cm.
- Plant produces root-suckers, coppices and pollards.
- It can be grown in red, lateritic to rocky soils of dry deciduous forests and on dry sandstone ridges.
- It is also grown on drier ridges of metamorphic rocks and easily planted in shelter-belts, windbreaks and hedges too [4].

Planting Material:

- It is propagated by seeds as well as cutting.
- Seeds are germinated immediately after collection.
- The rate of germination was found to be 25-30%.
- About two months old seedlings of 15-20 cm height is ready for planting in the field.
- A cutting of 1.0-2.0 cm thickness recorded 26% success but has poor survival in the field [4].

FIG. 3: *BOSWELLIA SERRATA* FORM

Agro-Technique:
Nursery Technique:
Raising Propagules and Transplanting:

- Seeds were obtained during May-June from selected plus trees.
- Seeds are sown during July-August, and about two months old seedlings are planted in the field at a spacing of 5 m × 5 m.
- Thus, about 400 plants per hectare are required for raising plantation [4].
- Planting in the Field

Land Preparation and Manure Application: Cross ploughing is done early in April followed by furrowing till a good tilt of soil is obtained and field is made free of weeds.

Well decomposed Farm Yard Manure (FYM) is added @ 20 t/ha during land preparation. It should be spread well and thoroughly mixed the soil.

Intercropping System: During initial 5-6 years, crops like ginger, turmeric, aloe, pineapple etc. can be grown as catch crops in between the trees.

Irrigation Practices: Crop requires irrigation at 15 days intervals during dry season beginning from December to June.

Weed Control: Hoeing and weeding is done during the first few years of growth.

Disease and Pest Control: No disease, pests, or other physiological disorder was observed in its cultivation. However, it would be advisable to dust pesticide against white-ants [4].

Harvest Management:

Crop Maturity and Harvesting: Its flower occurs during January-April, and seeds mature in May-June. Experimental cultivation recorded growth of 2.75 m in height in 3 years. Getting the bark and yield gum may require 8-10 years.

Post-harvest Management: Tapping for the oleoresin is done after plants reach a sizeable girth which is attained after 8 to 10 years.

Chemical Constituents: *Boswellia* oil is very similar to turpentine oil. The hydrolysis of the pure gum of *Boswellia serrata* yields mainly pentose (65% as arabinose) and small quantities of Galactose and Xylose. The gum also contains oxidizing and diastatic enzymes and 3.03% of total nitrogen [4].

Adulteration:

Known Adulterants and Substituents: *Boswellia* frereana, *B. sacra* (syn. B. carteri), other *Boswellia* species, Garuga pinnata (Burseraceae), Pinaceae resin (resin from tree species in the family Pinaceae) [1].

MATERIAL AND METHODS:

Preliminary Tests for Phytoconstituents [1]:

Test for Proteins:

- Trichloroacetic Acid Test
- Xanthoprotein Test

Test for Alkaloids:

- Dragendroff's Test
- Tannic acid Test

Test for Amino Acids

- Millons Test
- Ninhydrin test

Test for Carbohydrate

- Molish Test
- Barfoeds Test
- Seliwinoffs Test
- Test for pentoses

Test for Flavonoids

- Shinoda Test
- Alkaline reagent
- Zinc hydrochloride test

Test for Phenolic Compounds

Ferric chloride test

Test for Steroids & Triterpenoids

- Liebermann-Burchard Test

Identification & Standardization of *Boswelli Serrata*:

Extraction Methods: Petroleum ether of 40 to 60, benzene, chloroform, methanol solutions were obtained by a successive extraction method. The aqueous extract was performed by a maceration method [4]. Furthermore, all extracts were given a proximate chemical analysis.

- Hydro distillation.
- Steam distillation.
- Supercritical fluid carbon dioxide method.
- Soxhlet apparatus.

Identification Methods

Chromatographic Evaluation: TLC and HPTLC were carried out after making an appropriate solvent system with Ethyl acetate extract and Methanolic extract of Shallaki resin.

TLC: Thin-layer chromatography and High-performance thin layer chromatography were performed for the normal phase separation of components of ethyl acetate and methanol extracts of shallaki resin. Solvent system was prepared by taking Toluene: Ethyl acetate: Hexane: Formic acid in the proportion of 8:2:0.5:0.3, respectively. The spots obtained from both extracts were examined under ultraviolet light of wavelength 254nm and 366nm.The resolution factor (R_f) was calculated by using the formula. R_f = Distance traveled by solute/Distance traveled by solvent [4].

- Sample preparation: Track - 1: Ethyl acetate extract of Shallaki (EA) Track - 2: Methanol extract of Shallaki (MeOH)
- Solvent system - Toluene: Ethyl acetate: Hexane: Formic acid: (8:2:0.5:0.3)
- Stationary phase- Silica gel G

- Visualization-Under long U.V (366 nm) and short U.V (254 nm)
- Spray Reagent: Methanolic sulphuric acid

HPTLC: HPTLC study of the Ethyl acetate extract (Track 1) and Methanol extract (Track 2) was also carried out by using the same solvent system of Toluene: Ethyl acetate: Hexane: Formic acid (8:2:0.5:0.3). After completion of HPTLC, post chromatographic deprivation was done with Methanolic sulphuric acid [4].

- Track 1: Ethyl acetate extract of Shallaki
- Tack 2: Me-OH extract of Shallaki
- Solvent system: Toluene: Ethyl acetate: Hexane: Formic acid: (8:2:0.5:0.3)
- Spray Reagent: Methanolic sulphuric acid

Pharmacological Action: BAs inhibit human topoisomerase in two ways: catalytic and noncatalytic (I and II a). BAs reduce DNA synthesis in human leukaemia promyelocytic cells in a dose-dependent manner, but it also inhibits topoisomerase (I and II a) by competing with DNA for the enzyme's binding [8]. In human leukaemia, colon, hepatoma, and other cancer cell lines, the BAs (AKBA, KBA) exert their cytotoxic effects by blocking topoisomerase I and II, resulting in cell growth and proliferation suppression and causing death *via* a caspase-8 dependent mechanism. Interestingly, b-BAs suppress protein synthesis via interacting with ribosomal proteins and therefore affect cancer development, according to a mass spectrometry-based chemo proteomic method [8].

When HL-60 cells were treated with Acetyl-11-keto-b-Boswellic acid (AKBA), the cells showed dramatic morphological alterations, suggesting that they had gone into apoptosis. When *boswellic* acid, 3-O-acetyl-b-Boswellic acid, 11-keto-b-Boswellic acid, and 3-O-acetyl-11-keto-boswellic acid were tested for anticancer activity in HL-60 cells, they were shown to suppress the production of DNA, RNA and protein in a dose-dependent manner. It was discovered that it has an irreversible influence on DNA synthesis [8]. Oral administration of *B. sacra* gum resin hydro distillates (BSGRH) has recently been demonstrated to have chemo-preventive effects on urothelial cell cancer. Another study found that supplementing with BAscan can enhance the anticancer effects of doxorubicin in Ehrlich's ascites carcinoma solid tumours and protect animals from doxorubicin-induced cardiotoxicity [8].

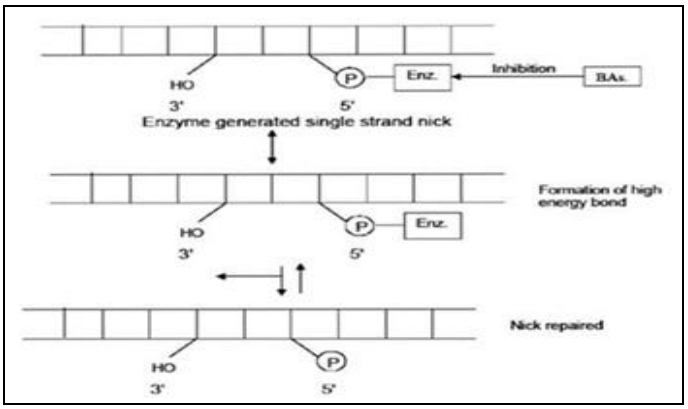


FIG. 4: PHARMACOLOGICAL ACTION ON CANCER CELL

Formulation of *Boswellia Serrata* Tablets: *Boswellia serrata* extract standardized to 65% ß-boswellic acid and croscarmellose were obtained as gift samples from Kisalaya Herbals Limited, Indore and Wyeth Laboratories, Goa, respectively. The chemicals and solvents used were of either pharmacopeia or analytical grade. Campbell Electronics, Mumbai, supplied various instruments like a Screw gauge, a Monsanto hardness tester, a Roche fabricator, and a Disintegration apparatus. USP XXIII dissolution apparatus-2 was from Tab-Machines, Mumbai, and 1601 PC Shimadzu UV spectrophotometer from Tokyo, Japan [11].

Herbal Raw Material Specification: Herbal material specifications were set as per WHO and CPMP guidelines. *Boswellia serrata* extract was studied for different physicochemical parameters like form, colour, odour, taste, total ash, acid insoluble ash, water soluble ash, moisture content, extractive values *viz.*, ethanol soluble extractives, water-soluble extractives, petroleum ether extractive, heavy metals, total bacterial count by the procedure given in the WHO guidelines and the Indian Pharmacopoeia 1996 [11].

Formulation of *Boswellia Serrata* Extract Tablets (BSE Tablets): All the formulations were prepared according to to follow [11].

- The drug extract and other excipients were mixed uniformly and made into granules by

the wet granulation technique. Either starch paste (20% w/v) or croscarmellose slurry (5% w/v) was used as a binding agent.

- The mass was forced manually through sieve no. 16 and was dried at 50 0 for 4 h.
- The dried granules were passed through sieve No. 22, superimposed on sieve No. 44.
- The granules retained on sieve No.44 were mixed with 15% fines.
- The resulting granules were mixed thoroughly with magnesium stearate and talc.
- The lubricated granules were compressed into tab* lets in a single punch machine with 500 mg die cavity [11].

TABLE 2: FORMULATION OF *BOSWELLIA* SERRATA EXTRACT TABLETS Both 2 formulation contains Drug and other ingredients in mg per tablet, SLS:

Ingredients	F1	F2
Drug	304	304
Starch	100	100
Lactose	64	39
SLS	-----	25
Talc	2%	2%
Mg. stearate	2%	2%
Starch Paste	20%	20%

FIG. 5: TABLETS OF *BOSWELLIA SERRATA*

Specifications for Herbal Medicinal Product (Tablets): The formulated *Boswellia serrata* extract tablets were studied in accordance with the CPMP guidelines, 2001. Five tablets were taken from each formulation and the thickness of each was determined by using a micrometer screw gauge. The hardness of five tablets from each formulation was determined using a Monsanto hardness tester. The tablet to be tested was held between a fixed and a moving jaw and reading of the indicator adjusted to zero. The force applied to the edge of the tablet was gradually increased by moving the screw knob forward until the tablet broke. The reading was noted from the scale, which indicated the pressure required in kg to break the tablet [11].

Uniformity of Weight: Twenty tablets were taken randomly and weighed. The average weight was calculated, then each tablet was weighed individually and weight was noted. The weights of individual tablets were then compared with the average weight (already calculated) to determine the percentage variation [11].

Friability Test: Twenty tablets were dusted, weighed, and placed in the Roche fabricator, which was operated for 100 revolutions at 25-rpm. After 100 rotations, the tablets were reweighed, and loss in weight was determined. The acceptable limit of friability is 0.5-1%. The initial weight of ten tablets before the revolution (WI), final weight of tablets after revolutions (W2) and the percent weight loss (friability) is given by where WI and W2 are the initial and final weights of ten tablets [11].

Disintegration Time: Six tablets were placed in the tubes along with a plastic disc over the tablets. The plastic disc does not allow the tablet to float and imparts a slight pressure on the tablets. The tubes were allowed to move up and down and disintegration time was noted when the tablets disintegrated and passed through the sieve [11].

***In-vitro* Dissolution Profile:** The dissolution profiles of tablets of *Boswellia serrata* extract were determined by using a six-panel USP XXIII dissolution apparatus-2 taking 900 ml of physiological buffer solutions of pH 1 .2 and pH 7.4 containing 10% of methanol as dissolution media. The dissolution media were maintained at a temperature of 37 ± 10 °C. The speed of rotation of the paddle was 50 rpm. The samples were taken out at appropriate time intervals, and the absorbance was noted at 254 nm in a 1601 PC Shimadzu UV spectrophotometer. Ten tablets of each formulation were crushed, shaken with 250 ml of methanol, and filtered. The drug content in soft-flion was analyzed spectrophotometrically at 254 nm [11].

Marketing:

Market Dynamics of *Boswellia Serrate*: The *Boswellia serrate* market is expected to witness high demand due to increasing emphasis on using

plant-based materials as a source of medicine for treating various human ailments. Companies in the *Boswellia serrate* extract market are keen to introduce ingredients that support high health and wellness functionality. This is expected to contribute significantly to the growth of *Boswellia serrate* market. Rapid urbanization and the consumers becoming highly health conscious are expected to contribute significantly to the revenue growth of *Boswellia serrate* market. Some other factors escalating the demand for *Boswellia serrate* include continuous new product developments and an improved supply chain that ensures the wide availability of *Boswellia serrate* in the industry. Food technologists and companies in the *Boswellia serrate* market also focus on research & development activities to increase the utility of *Boswellia serrate* in various applications [7].

Market Segmentation of *Boswellia* Serrate: *Boswellia serrate* market is segmented based on application, form, and geography. Based upon application, *Boswellia serrate* market is segmented into food, pharmaceuticals, cosmeceuticals, and others. Pharmaceutical application of *Boswellia serrate* market is expected to attain a relatively higher market share during the forecast period. The high revenue share of pharmaceutical applications in the *Boswellia serrate* market can be attributed to its medicinal properties. The cosmeceutical application of *Boswellia serrate* market is expected to grow at a relatively high CAGR over the forecast period. The high growth of the cosmeceuticals segment is expected to be driven by its increasing contribution to effectively treating skin diseases. It also plays a vital role in treating photo-aging, chronic skin damage caused due to excessive exposure to sun. On the basis of form, *Boswellia serrate* market is segmented into dry and liquid forms. The dry form of *Boswellia serrate* is expected to contribute significantly to the revenue growth of the global *Boswellia* market during the forecast period [4].

Marketed *Boswellia Serrata* Formulations: Available in Extract Capsule and Tablet form.

- Healthy Hey *Boswellia* Extract
- Natureal *Boswellia* 800 mg Capsules
- INLIFE *Boswellia* Extract

FIG. 6: OLEO GUM RESIN FORM

CONCLUSION: *Boswellia Serrata* is also used as a potent anti-neoplastic agent in various types of cancer like Breast cancer, Pancreatic cancer, etc. Frankincense, once used in religious ceremonies and valued as gold in trading, has enjoyed popularity in both traditional systems and modern medicine due to its numerous beneficial therapeutic properties. BAs, the pentacyclic triterpenoids, are Boswellia's bioactive phytoconstituents, of which AKBA has shown promising results in experimental and clinical studies. It is considered a potential pharmacophoric molecule of natural origin that can play a vital role in drug discovery of anti-inflammatory and chemotherapeutic agents. Though the standardized extract preparations of Indian and Chinese *Boswellia* are available in the international market for the treatment of inflammatory disorders pure AKBA preparations are yet to enter the market. Future challenges lie in understanding the molecular mechanisms at the cellular level, drug-drug interactions, development of methods to improve the pharmacokinetic properties, especially oral bioavailability, and formulation of a stable preparation.

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CONFLICTS OF INTEREST: Nil

REFERENCES:

1. Ahmed HH, Abd-Rabou AA, Hassan AZ and Kotob SE: Phytochemical analysis and anticancer investigation of *boswellia* serrata bioactive constituents in-vitro. Asian Pac J Cancer Prev 2015; 16(16): 7179-88.
2. Alotaibi SH: Biophysical properties and finger print of *Boswellia Sp*. Burseraceae. Saudi J Biol Sci 2019; 26(7): 1450-57.
3. Iram F, Khan SA and Husain A: Phytochemistry and potential therapeutic actions of *Boswellic* acids: A mini-review. Asian Pacific J of Trop Biome 2017; 7(6), 513-23.
4. PK Gupta, Chandola Harimohan, Harisha Channappa, Shukla Vinay, Gupta Varun and Nariya Pankaj: Pharmacognostic and Phytochemical evaluation of Oleo

gum-resin of shallaki *Boswellia serrata* Roxb. Journal of Pharmaceutical and Biomedical Sciences 2011; 6: 1-5.
5. Al-Yasiry AR and Kiczorowska B: Frankincense--therapeutic properties. Postepy Hig Med Dosw Online 2016; 70: 380-91.
6. Suhail MM, Wu W, Cao A, Mondalek FG, Fung KM, Shih PT, Fang YT, Woolley C, Young G and Lin HK: *Boswellia sacra* essential oil induces tumor cell-specific apoptosis and suppresses tumor aggressiveness in cultured human breast cancer cells. BMC Complement Altern Med 2011; 11: 129.
7. Efferth T and Oesch F: Anti-inflammatory and anti-cancer activities of frankincense: Targets, treatments and toxicities. Semin Cancer Biol 2020.
8. Khan MA, Ali R, Parveen R, Najmi AK and Ahmad S: Pharmacological evidences for cytotoxic and antitumor properties of *Boswellic* acids from *Boswellia serrata*. J Ethnopharmacol 2016; 191: 315-23.
9. Falzon CC and Balabanova A: Phytotherapy: An introto herbal medicine. Primary Care 2017; 44(2): 217-227.
10. National Cancer Institute Whatis Cancer. https://www.cancer.gov/about-cancer/understanding/what-is-cancer.
11. AA Shirwaikar, Annie Shirwaikar, HN Aswatha Ram and DK Upadhyay: Formulation and evaluation of *Boswellia serrata* tablets. Indian Journal of Pharmaceutical Sciences 2005; 67(4): 427-43.

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