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Ayurvedic Perspective of Calcium Supplementation- A Review

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Abstract

Calcium is an essential nutrient of the human body. The main source of calcium in the body is from the food we eat. But the absorption of calcium is limited due to the presence of phytates, oxalates, etc. Many countries in Asia have average dietary calcium intake less than 500 mg/day. Countries in Africa and South America mostly have low calcium intake between about 400 mg/day and 700 mg/day. Only Northern European countries have national calcium intake greater than 1000 mg/day. Hence there is a need to depend on calcium supplements. Several forms of calcium compounds are used as supplements. Calcium supplementation has its own advantages and disadvantages. The inability to ascertain proper absorption from the gut, selection of suitable compound as per clinical condition, dose fixation etc. are challenges of modern calcium supplementation. Ayurveda uses drugs from plant, animal and mineral origin as calcium supplements. Ayurvedic calcium supplements are used in a wide range of morbidities ranging from fever to cardiac ailments. These articles highlight the calcium supplementation from ayurvedic perspective in the light of the classical literature and recent researches in these aspects.

Keywords: Ayurveda; Calcium deficiency; Calcium supplementation

Introduction

Calcium is an essential nutrient for the human body. Calcium is the key component that mediates muscle contraction, exocrine, endocrine and neurocrine secretion, cell growth, and the transport and secretion of fluids and electrolytes. It is soft gray alkaline earth metal and most abundant element by mass in the earth crust after oxygen, hydrogen, carbon, and nitrogen. It is also fifth most abundant dissolved ion in sea water. It accounts for about 2% of adult human body weight. Over 99% of total body calcium is found in bones and teeth, remaining part is present in the blood, extracellular fluid, muscle and other part of the body. The rigidity of the skeleton is due to the insolubility of calcium mixed with phosphoric acid-forming mineral hydroxyapatite. The normal Ca^{2+} level in human plasma is about 8.5 to 10.4 mg/dL. The recommended dietary intake of calcium for adolescents and adults to age 24 is 1, 200 mg/day; for older adults, it is 800 mg/day [1].

The Ca^{2+} ion is essential in a wide variety of important physiological processes, including muscle contraction, neuronal excitability, neurotransmitter and hormonal release, membrane integrity and permeability, signal transduction, enzyme function, and blood coagulation. It can slow bone loss in postmenopausal women, may reduce premenstrual syndrome symptoms, and is associated with reduced risk of colorectal cancer. It can also reduce chronic hypertension due to Ca^{2+} deficiency. Calcium salts are mainly intended to correct calcium deficiency in osteoporosis. as an antacid, as phosphate binders, acute treatment of tetany, lead colic, urticaria and nonspecific intestinal colic, placebo hyperkalemia, and cardiac arrest [2].

Calcium-rich marine products and minerals have been used since 2500 years. Charka Samhita described the uses of Calcined cowries (*sankha*), *Mukta* (Pearl), *Pravala* (coral) and *vanshalachana* for the cure of diseases and wellness [3].

Literature Review

Calcium containing drugs in Ayurveda

In Ayurveda, drugs are classified into three depending upon the origin viz *Jangamam* dravyas (drugs of animal origin-Table 1); *Oudbhida dravyas* (drugs of plant origin-Table 2) *Parthiva dravayas* (drugs of mineral origin-Table 3). The drugs rich in calcium from the animal origin and mineral origin were discussed in detail in *Rasasatra (Ayurveda mineralogy)*. All the drugs of mineral origin and animal origin rich in calcium are grouped under *Sudha vargadravyas*. The literal meaning of the word Sudha means ambrosia or nectar. In the Ayurvedic classics Caraka Samhita and Susrutha Samhita, *Sudha* has been included under *parthivadravyas. Rasamritam* describes a separate group of drugs in the chapter *Sudha vijnaneeya*, whereas, in *Rasa Ratnakar* and *Rasarnava, suklavarga* is mentioned instead of *Sudha Varga,* owing to the white color of the drugs in this group. The number of drugs in *Sudha Varga* is different according to various authors. There are about 18 drugs in this category from the various textbooks of *rasasastra* [4]. The amount of calcium in herbal drugs was elaborated recently after more advances in herbal drug research (Tables 1- 4) [5- 15].

Calcium deficiency – Ayurvedic perspective

Ayurveda deals elaborately with various aspects of dietetics. But the description of macro and micronutrients are not available in the classical literature. The calcium deficiency symptoms can be viewed from two different perspectives – as *vatadosha vridhilakshana* and *asthi dhatu kshayalakshana.*

Nirukti of *Vatadosha* is derived from the root words Va and Ta meaning *gati* - to move and *gandhana* meaning energy. Vatadosha initiates all the movements and action in the body. When aggravated it produces different kinds of pain sensations like catching, twitching, aching, contractions, numbness, pricking, etc. [16] various pain manifestations of the muscular and skeletal systems, numbness of digits, etc. are seen during the insufficiency of calcium in the body. Just like the painful menstrual syndrome associated with calcium insufficiency, the *udavartini yoniroga* is manifested as painful and scanty menstruation [17]. *Balaupaghata* (decreased level of energy or enthusiasm) is a characteristic feature of *vatavridhi.* Lethargy is also seen associated with calcium deficiency. The features of osteoarthritis like edema, arthralgia, and restriction of movement are the same as that of *sandhiga tavata* [18].

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S. No	Name of the drug	Common name	Percentage of calcium
1	*Sudha*	Lime	--
2	*Khatika*	Chalk	--
3	*Godanti*	Gypsum	95.99%

Table 1: *Parthivadravyas,* containing calcium and their respective concentrations [5].

S. No	Name of the drug	Common name	Percentage of calcium
1	*Sankha*	Conch shell	63.94%
2	*Shambhuka*	Snail	-
3	*Mutasukti*	Pearl oyster shell	82.90%
4	*Kaparda*	Cowery shell	67.48%
5	*Kurma prishta*	Turtle shell	-
6	*Samudra phena*	Cuttle fishbone	-
7	*Pravala*	Coral	72.07%
8	*Mukta*	Pearl	-
9	*Mrigasringa*	Deer antlers	-
10	*Kukkutandatwak bhasma*	Hen's egg shell	76.55%
11	*Ajasthi*	Goat's bone	Calcium-phosphorus

Table 2: *Jangam dravyas* containing calcium and their percentage [6].

S. No	Name of the drug	Scientific Name	Percentage of calcium
1.	*Asthisamhara*	*Cissus quadrangularis*	Stem – 1.76 g
			Leaf – 1.68 g
			Root – 1.51 g
2.	*Satavari*	*Asparagus racemosus*	961-2115 mg/kg
3.	*sigru*	*Moringa olifera*	1.16 g/100 mg – leaves
4.	*tila*	*Sesamum indicum*	2.41 -1.16 g/100 g
5.	*Adraka*	*Zingiber officianale*	64-69 mg/100 mg
6.	*Haridra*	*Curcuma longa*	0.2%
7.	*Ashwagandha*	*Withania somnifera*	3.3 mg/100 g
8.	*Silajatu*	*Asphaltum punjabinum*	Contain calcium salts of humic acid and fulvic acid
9.	*Arjuna*	*Terminalia arjuna*	Contain calcium oxalate

Table 3: The *Audbhida dravyas* containing calcium and their percentage [7-14].

Calcium is stored mainly in the skeletal system of our body. *Asthi dhatu* may be understood as the skeletal frame work of the body. The appendages of our body, mainly hair (of the scalp and body), nails and teeth are considered to be formed from the *asthi dhatu* (as mala and upadhatu). The characteristic features of asthi dhatu kshaya are *asthisoolam* (pain in bones), hair fall, cracking of teeth and brittleness of nails. These signs are very similar to those seen in calcium insufficiency. The *vatadosha* and *asthi dhatu* are associated with each other by *asraya (asthi)*– as*rayi bhava (vata)*. The reason for *vataprakopa* is in short – *dhatu kshaya* and *avarana*. Hence, the *kshaya* of *asthi dhatu* may be considered as a reason for *vataprakopa* the recent clinical and experimental studies shows that deficiency of calcium is associated with the loss of bone matter. This may be considered as the *dhatu ksaya* which further triggers *vataprakopa*. Those signs and symptoms of *vataprakopa* reflected on the musculoskeletal system and that of *asthi dhatu kshaya* may be correlated with the signs and symptoms of calcium insufficiency reflected on the musculoskeletal system [19].

Calcium supplementation

The diseases treated with calcium supplements fall in 3 categories.

1. Used to overcome calcium malabsorption by increasing the diffusion component of absorption. They include hypoparathyroidism, osteoporosis, malabsorptive bowel syndrome. The most common use of calcium supplementation is for the prevention of age-related osteoporosis
2. Calcium is used for chelating certain anions, mainly phosphate. It is used in chronic renal failure, where there is a reduction in phosphate absorption. It is also used in age-related osteoporosis.
3. Symptomatic gastric acidity – calcium carbonate is used as an antacid between meals to neutralize gastric acidity in gastro-esophageal acid reflux disease and peptic ulcer disease (Table 5) [20,21].

Robable mode of therapeutic action

Therapeutic use of calcium salts according to modern science is to prevent or correct calcium deficiency or osteoporosis, as an antacid, as phosphate binders, acute treatment of tetanus, urticaria and nonspecific intestinal colic, hyperkalemia and cardiac arrest.

The first and second category of calcium supplementation is used in calcium malabsorption and in age-related osteoporosis. This may

S. No	Name of drug	Research finding
1.	*Godanti*	*Godanti bhasma* contains 42.3% calcium as calcium oxide when analyzed by gravimetric method.
2.	*Sankha*	TGA study shows that chemical present in *Sankha bhasma* is calcium oxide
3.	*Muktasukti*	Calcium carbonate and aragonite are present with an immense reduction in particle size which allows penetration of drug at the cell level.
4.	*Pravala*	Found effective in prevention of calcium and estrogen deficient bone loss.
5.	*Mukta*	Calcium carbonate and aragonite are present with an immense reduction in particle size which allows penetration of drug at the cell level
6.	*Kukkutanda twak*	SEM analysis shows the presence of calcium, magnesium, and sulfur
7.	*Asthisamhara*	Contain a high amount of anabolic steroidal substances, calcium, and phosphorus. Helps in fracture healing and quick mineralization.
8.	*Tila*	Inhibited excessive loss of calcium in urine, reduced serum alkaline phosphatase activity.
9.	*Satavari*	The fruit extract shows a positive effect on calcium balance and preventing bone loss
10.	*Sigru*	Seeds area rich in calcium, copper, and manganese. Reduces pain and swelling arthritis.
11.	*Ardraka*	Ginger oil extract supplementation reduced urinary excretion of calcium, phosphate, and hydroxyproline.

Table 4: The recent research findings on the calcium containing drugs in Ayurveda [7-15].

S. No	Name	Indication	dose
1.	*Godanti bhasma*	Rickets, Osteoporosis	125-250 mg
2.	*Kukkutandatwak bhasma*	Rickets, supplement during pregnancy, lactation, dental eruption	250-500 mg
3.	*Ajasthi*	,,	,,
4.	*Pravala pishti*	Rickets with cough	-
5.	*Sringa bhasma*	Strengthen bones and cartilages	60-125 mg
6.	*Shuktadi yoga*	Calcium supplement	125-250 mg
7.	*Muktadi vati*	Rickets.	250-500 mg
8.	*Balavati*	,,	,,
9.	*Balapanchabhadra churna*	Rickets	,,
10.	*Sudhashataka yoga*	,,	250 mg-1000 mg
11.	*Abha guggulu*	Fracture healing	250-500 mg
12.	*Lakshadi guggulu*	Fracture healing	250-500 mg

Table 5: Drugs and formulations commonly used in clinical practice as calcium supplements [21].

be interpreted as the correction of *asthi dhatu kshaya* and *vatavridhi.* Samprapti vighatana (breaking of pathogenesis) is the prime line for the treatment of any disease in Ayurveda. So, treatment of asthikshaya should be done considering both the facts for *vataprakopa (mitigating aggravated vata dosha)* that is *margavaran* (cleansing channels) and dhatu kshaya [22]. In margavaran, strotoshodhak treatment should be given which clears the channels and nourishes the next dhatu. The calcium-rich herbal Drugs or medicinal plants are mostly having katu, tikta rasa, snigdhaguna. tikta rasa is having strotoshodhak property which acts on margavaran.

The third category of calcium supplementation is in symptomatic gastric acidity. Apart from the *oudbhida* and *jangama dravyas*, the *parthiva dravyas* are of importance here. Majority of the *parthivadravyas rich in calcium* are *seetaveerya.* All of them are *grahi, chakshushya*, *deepana, pachana, vishaghna*. They are rich in mineral calcium, hence can be used as supplements of calcium. Apart from this, they can also be used in the treatment of *amlapitta, parinamasula* etc. The *bhasmas* of these drugs are mostly carbonates of calcium. When administered along with water or suitable *Anupama*, they dissociate into oxide or hydroxide form. On reaction with the acidic gastric juice, the above-formed compound gets converted to chloride and then to elemental calcium ion, which is absorbed. Hence they can be used as supplements of calcium in various conditions. The chloride ion nullifies the acidity. Hence the action of these drugs in conditions like *amlapitta, parinamasula*etc can be justified. Moreover, drugs like *sankha, sukti, mukta,* etc are *seetaveerya* and *pitta hara.* Hence they help to correct the conditions like *amlapitta, parinamasula*etc [23].

Advantages of Ayurveda drugs over modern calcium supplements

The *parthiva* and *jangama dravyas* rich in calcium act as a direct source of calcium to the body. They also help to rectify calcium malabsorption or a*sthi dhatu kshaya* and *vataprakopa* which manifests as calcium deficiency symptoms in the body.

The *parthiva dravyas* are consumed in the form of *bhasmas* except for *mukta* and *pravala*. They contain other elements in them along with calcium. *Godanti bhasma* contains sulphur, *Sringa bhasma c*ontains zinc, magnesium and other heat stable amino acids. Due to the reason that the *bhasmas* of *sudhavarga dravyas* contain other elements in trace forms and that they are mild oxides and carbonates that can be easily absorbed and assimilated. These are usually alkaline in nature. The synthetic molecules cannot be absorbed in unhealthy gut conditions. On the other hand, the *sudhavarga dravyas* help to correct the abnormalities in the gut, heals ulcers imparts anticolic activity. The presence of oxalate and phytates reduces the absorption of calcium from synthetic molecules. Only 10% of the calcium consumed will be absorbed from a synthetic compound [24].

Calcium supplementation has its own advantages and disadvantages; it's a double-edged sword. Favorable role of calcium is seen in all age groups of people. It is necessary for optimum amounts in children and adolescence to build strong bones and muscles. In adults, calcium supplementation reduces the risk of fractures and osteoporosis. Some recent evidence suggest that calcium supplementation might increase the risk of cardiovascular diseases and malignancy. A study indicated the risk of myocardial infarction remarkably increased by taking calcium supplements. Calcium supplements may increase the incidence of constipation, severe diarrhea, abdominal pain, flatulence and bloating. Studies indicate that individuals who consume supplemental calcium are at greater risk of developing kidney stones than individuals who did not consume calcium supplements. Calcium supplementation is also associated with an increased risk of developing age-related macular degeneration and metabolic syndrome.

Many factors affect the good and bad results of calcium supplementation. The type of calcium salt that is suitable for each condition and age has not been clearly determined. The exact dose to be consumed in different conditions has not been elaborated experimentally or clinically. Different dosage forms of calcium give different results. Dietary calcium seems to exhibit more benefits than calcium supplements. But the absorption of dietary calcium is hindered by the oxalates and phytates present in them [21].

Discussion

Ayurveda uses a large number of *dravyas* of different origin, rich in calcium. The mineral drugs are subjected to *swedana* and *marana* processes with suitable mediums depending upon the chemical composition of the *dravya*. Most of the s*odhanadravyas* are *amla (sour)* in nature which helps to remove the impurities from the *sudhavargadravyas* which are usually alkaline in nature. The *marana* process further converts them into very fine particles of micro-level. These processes help to convert these calcium compounds to more absorbable and assimilable forms. By virtue of various pharmacological properties *madhura-kashayarasa, seetaveerya, madhuravipaka,* etc,

these dravyas helps to correct the gut morbidities like *parinamasoola, amlapitta* etc by their properties of ropana, etc. Further, the pH of the gut gets corrected which in turn enhances the absorption of calcium. This is the greatest advantage of Sudha vargadravyas over modern calcium supplements. Most of the modern calcium supplements impart constipation, bloating etc. On the other hand, the Sudha vargadravyas are deepana-pachana in nature, which prevents these complications. They will cause mild gastric irritation and the modern calcium supplements will not be absorbed in various conditions of gut morbidities [6].

Another important controversy regarding the modern calcium supplementation is the difficulty to determine the form of calcium salt in various supplements. The *dravyas* after *sodhana -marana* process, which so ever may be the form in the raw state, will be converted to carbonates. Carbonates of calcium are the most easily absorbed and assimilable form rather than other salts. The presence of other trace elements like zinc and magnesium will enhance the absorption of these compounds. They are also administered along with a suitable anupana depending on the condition of the disease, which further aid the absorption and assimilation of these compounds over the modern calcium supplements [25].

Apart from *bhasmas*, various dosage forms are available, which gives the physician to select from a wide range so as to best suit the condition of the patient and disease.

The dose fixation of modern calcium supplements is another limitation. With regard to the Ayurveda drugs and formulations, the dose of each drug in different formulations, a dose of various compound formulations, etc. has been fixed depending upon the compound present. In addition, suitable *anupanas (vehicle)* have also been described to ensure the absorption of optimum quantity of calcium from these compounds and to ensure that the desired therapeutic action will be obtained from each drug. As the dose of modern calcium supplements is not fixed, sometimes it may lead to inadequate or excess levels of calcium than the desired levels which may precipitate adverse reactions.

Conclusion

From the evidence from the classical literature and recent researches, it can be concluded that the Sudhavarga dravyas can be considered as the calcium-containing drugs in Ayurveda. They have a wide range of therapeutic implication from jwara (fever), raktapitta (bleeding disorders), swasa (breathing difficulty), kasa (cough), hridrog (cardiac ailments), khalitya (baldness), palitya (prematuregreying), amla pitt (acid eructation), parina masoola (peptic ulcer) etc. and in various external applications like vasti, avachoornana etc. Recent researches on experimental pharmacology have proven that coral calx improves bone mineral density. Ayurveda dravyas have many advantages over modern calcium supplements as they are available in various dosage forms; they have a fixed dose and adjuvant which ensures proper absorption. They can be used even in the presence of various gut morbidities. Though they can be successfully used as calcium supplements in various conditions, there is no reference of calcium containing drugs in Ayurveda being used in bhagna. The further focus has to be brought to establish the use of Ayurveda drugs and formulations as calcium supplements in various conditions by clinical and experimental models.

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