CHAPTER

9

CLAYS FOR MEDICINES AND FILLERS

9.1 ROLE OF CLAY IN MEDICAL SCIENCE

Clay plays an important role in medical science to prepare various medicines. This special aspect of clay is known as clay therapy. It is based on the ability of clays and clay minerals to adsorb and retain harmful and toxic substances. The beneficial effects of these materials to human health, notably in the treatment of gastrointestinal disorders, have been recognized. Among the variety of clays and clay minerals that were used by primitive tribes are bentonite, kaolinite, montmorillonite and smectite. The word medicine is derived from the Latin word "*medicina*". Medicine is the science and art of healing. It encompasses a variety of health care practices evolved to maintain and restore health by the prevention and treatment of illness in human beings. Prehistoric medicine incorporated plants, animal parts and minerals.

9.2 ADSORPTIVE PROPERTIES OF CLAY MINERALS

A. Microorganisms

In the stomach, *Helicobacter pylori* is associated with gastritis and gastroduodenal ulcers. This bacterium is also one of the most important ethiopathogenic factors causing peptic ulcer. Smectite, on HeLa cells infected by *H. pylori* isolated from human biopsies, significantly reduces adhesion of the bacteria to the surface of epithelial cells. This is why smectite is effective in treating the symptoms of people with non-ulcer dyspepsia who are infected by *H. pylori*. Clay minerals are efficient drugs for treating disorders of the gastrointestinal mucosa, induced by microorganisms. Kaolinite and montmorillonite are capable of adsorbing viruses. As such, these minerals can induce rapid recovery when administered to children suffering from

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gastroenteritis. Similarly, the strong adsorptive power of smectite lies behind its ability to aggregate bacteria. In the intestine, smectite is effective against diarrhoea as shown by clinical data for new-born calves with neonatal gastroenteritis.

B. Gas

Clay minerals can serve as gas adsorbents in patients with symptoms of flatulence and abdominal distension. Thus, smectite can reduce the amount of hydrogen emitted during colonic fermentation.

C. Alimentary Allergy

Food allergy is also responsible for disturbances in colonic transit, water absorption and intestinal permeability. Guinea pigs that were sensitized by b-lactoglobulin from cow milk show colonic transit acceleration, a colonic hypersecretory response, a strong increase in intestinal permeability, and a decrease in faecal dry matter. These effects are not observed in animals that were treated with smectite. Clays can inhibit anaphylaxia probably by controlling the release of mediators at the origin of the degranulation of the mast cells.

D. Toxins

Due to adsorptive property, clays can adsorb a variety of toxic substances, such as strychnine, mycotoxins, aflatoxin and toxins. Clay can provide active protection against disturbances during gastrointestinal transit. However, if the toxin is incubated with smectite for 24 h beforehand, no increase in the rate of gastric emptying and small intestinal transit occurs. Smectite can also adsorb the enterotoxin of *Clostridium difficile*. In rats, this toxin causes intestinal permeability to increase through hypersecretion of colonic water.

E. Pesticides

Clay minerals can also protect the digestive mucosa against pesticide damage. Diquat, a widely used non-selective desiccant herbicide, induces erosion of intestinal mucosa and fluid hypersecretion. Similarly, montmorillonite and bentonite are good adsorbents, and may be recommended for the treatment of pesticide poisoning.

9.3 USEFULNESS OF CLAY IN CLINICAL ASPECT

Clay minerals are efficient against several ‘aggressors’ that cause major disorders of the gut. These beneficial effects of clay minerals are associated with their toxic secretions and modification of the thickness and rheological properties of the adherent mucus.

Clay minerals are efficacious against several aggressive agents causing severe intestinal disorders due to good adsorbents properties. By adsorbing viruses, bacteria clay minerals can reduce the occurrence of prolonged diarrhea. Simultaneously these minerals do not interfere with the electrolyte balance and so, are easily tolerated by patients. Clay minerals also provide protection against diarrhoea induced by antibiotic treatments. Clay minerals are promising drugs in the treatment of irritable bowel syndrome (IBS), a rather frequent disease in adults with a complex pathogenic mechanism.

9.4 INTERACTIONS OF CLAY MINERALS WITH GASTROINTESTINAL MUCUS

The mucus gel is largely composed of glycoprotein polymers, lipids and proteins, linked together by covalent bonds. As such, it acts as a physical barrier protecting the mucosa against penetration by extraneous molecules and mechanical injury. By maintaining a pH gradient and competing with the epithelial surface for microorganisms, the mucus gel also acts as a chemical barrier. Thus, a weakening of the mucus gel barrier may be at the origin of disorders. The short-term treatment with clay minerals, such as smectites, increases the thickness of the adherent mucus. These may be ascribed to interactions of mineral particles with mucus components, by which the gastrointestinal glycoproteins are modified and their polymerization is enhanced. Similarly bohemite reduce mucus degradation. The beneficial effects of minerals are also associated with improvements in the rheological properties of the mucus gel. This reflects the increased extent of polymerization, and the improvement in quality, of the adherent mucus. Clay minerals help to bring changes in physico-chemical properties.

9.5 MEDICAL CARE

The provision of medical care is classified as primary care, secondary care and tertiary care as shown in Table 9.1.

Table 9.1: Provision of medical care

Primary care	This kind of services is provided by physicians and/or medical assistants.
Secondary care	Patients needing more medical care are referred/treated in medical centres.
Tertiary care	Patients needing specialized medical treatment are provided by specialist medical centre.

In all these stages of treatment, tablet medicines used contain clay filler as medium factor. Variation of strength of medicine is controlled by amount of filler used during tablet preparation.

9.6 CLAY MINERALS IN PHARMACEUTICAL FORMULATIONS

The use of clay minerals in pharmaceutical formulations was described by many authors (Del Pozo 1978, 1979; Gala´n et al., 1985; Bech, 1987; Cornejo, Kaolinite, talc, palygorskite and smectites are used for therapeutic purposes in pharmaceutical formulations as active principles or excipients. The possible use of sepiolite as active principle or excipient in pharmaceutical formulations was also investigated and there are commercial medicines that include sepiolite in its composition (as active principle and excipient). The fundamental properties for which clay minerals are used in pharmaceutical formulations are high specific area and having sorptive capacity and favourable rheological characteristics.

9.7 MAIN PROPERTIES OF CLAY MINERALS USEFUL IN AESTHETIC MEDICINES

1. Appropriate rheological properties for the formation of a viscous and consistent paste; and good properties for easy application, and adherence to the skin during treatment.
2. High heat-retention capacity: As heat is also a therapeutic agent, clay minerals are applied hot to treat chronic rheumatic inflammations, spot traumatisms and dermatological problems.
3. High sorption capacity: Clays can eliminate excess grease and toxins from skin, and hence are very effective against dermatological diseases such as boils, acne, ulcers, abscess and seborrhoea. An organic active principle can also be incorporated into the clay mineral before its application to the patient's skin for therapeutic purposes.
4. Softness and small particle size since the application of the mud, particularly as face mask, can otherwise be unpleasant.
5. Smectites (bentonite clays) fulfil many of the requirements for usage in spa and beauty therapy.

9.8 IMPORTANCE OF FILLERS

The term 'Filler' indicates something used to fill gaps; mainly fillers are particles added to material (plastics, composite material and concrete) to improve some properties of the mixture material. Worldwide more than 53 million tons of fillers are used every year in different application areas, such as paper, plastics, rubber, paints, coatings, adhesives and sealants. As such, fillers, produced by huge number of companies, rank among the world's major raw materials and are a major constituent in a variety of goods for daily consumer needs.

9.9 TYPES OF FILLER

Formerly, fillers were used predominantly for final finishing of end products, in which case they are called extenders. Among the 21 most important fillers, calcium carbonate holds the largest market volume and is mainly used in the plastics sector.

In some cases, fillers also enhance properties of the products, e.g. in composites. In such cases, a beneficial chemical interaction develops between the host material and the filler. As a result, a number of optimized types of fillers or surface treated goods have been developed.

Table 9.2: Uses of clay minerals as fillers

Industry	*Clay family*
Plastics, rubber, paper industry	Kaolin, talcum, pyrophyllite
Cosmetics, plastics	Palygorskite, sepiolite

9.10 CLAY AS FILLER

Composition

This discussion will be limited to kaolin, the most common form of clay added to paper as a filler. Bentonite is a generic term for montmorillonite clay. Kaolin is a hydrated silica-aluminate. Deposits of kaolin particles have been built up by natural geologic processes. In one of these processes the kaolinite is initially released by glaciation. Rivers carry silt in the glacial runoff and deposit it in shallow seas. Larger particles settle first, then the finer ones, usually at a different location. By choosing their locations, clay producers have access to a range of particle sizes and brightness of kaolin particles. High quality deposits of kaolin, having moderately high brightness and uniform particle size are found all over the world, especially in China, Georgia, Brazil and England. Anionic dispersants such as phosphates and acrylates are usually added to clay as it is collected and processed. The particles are typically irregular hexagons with a layered underlying structure. The size is highly variable; filler clays usually are selected with an average (SEM) particle size of about 1 to 3 micrometres. When the kaolin is first released it is likely to contain dark and abrasive impurities. Processing steps can include sieving, centrifugal cleaning, magnetic removal of dark contaminants, and bleaching. After these processes the particles of kaolin is still likely to resemble "books," comprised of layers. This is the most common type of clay used for paper filling, especially when it is important to maintain strength at a given filler level. Extended agitation of clay slurries in the presence of hard ceramic balls (of visible size, much larger than the kaolin particles) causes the kaolin to delaminate into thinner platelets. This is delaminated clay.

Function

Besides reducing the cost of paper, clays are especially useful for creation of gloss (in highly filled, supercalendered papers), for increasing resistance to air flow (in the case of delaminated clays), and for imparting a moderate decrease in the friction coefficient of paper (especially when added to the size-press solution).

Strategies for Use

The main concerns are (a) How high a filler level is best?; and (b) How to achieve an adequate retention?

A uniform dispersion of clay can be obtained with conventional dispersing equipment, e.g. a Cowles mill. Also it is possible to get bulk delivery of clay slurries with solid levels in the neighbourhood of 70%. The price that one pays for the convenience of using pre-slurried clay is that it contains anionic dispersants. These can make retention more difficult. Coating grades of clay are especially difficult to handle at high levels in the wet end due to the combination of dispersants, higher surface area, and smaller particles that are harder to filter from the water as the paper is being formed. The content of clay in paper usually is limited by decreasing strength properties and decreasing caliper at a given smoothness and basic weight. Clay tends to produce dense paper, especially when it is calendered. Unlike calcium carbonate fillers, clay products can be used at any pH. Clay will form agglomerates if prematurely mixed with such additives as cationic starch, alum, retention aids and the like. Intentional agglomeration of filler is a potential way to increase the strength of paper at a given filler content; however this technology has not become widely used. Most retention aid systems are effective with clay. Ashing of the paper at 900 °C drives off waters of hydration. If a paper sheet is assumed to contain only hydrous kaolin (not calcined clay), the percent ash needs to be divided by 0.86 to estimate the percent of clay originally present in the paper.

Cautions

Normal precautions regarding dust need to be observed when clay is received as a dry powder.

9.11 USES OF FILLER

Fillers are used for packaging, mainly for food. These are used to fill either a bottle or a pouch, depending on the product. There are several types of fillers used by the packaging industry, those listed below are the most common.

- **Auger/Agitator Filling Machine:** This machine is designed as to fill dry mixes, such as flour and sugar. The fillers have a hopper shape like a cone that holds the mix and puts it in a pouch using an auger screw that is controlled by the agitator and so it's called Agitator Filling Machine.

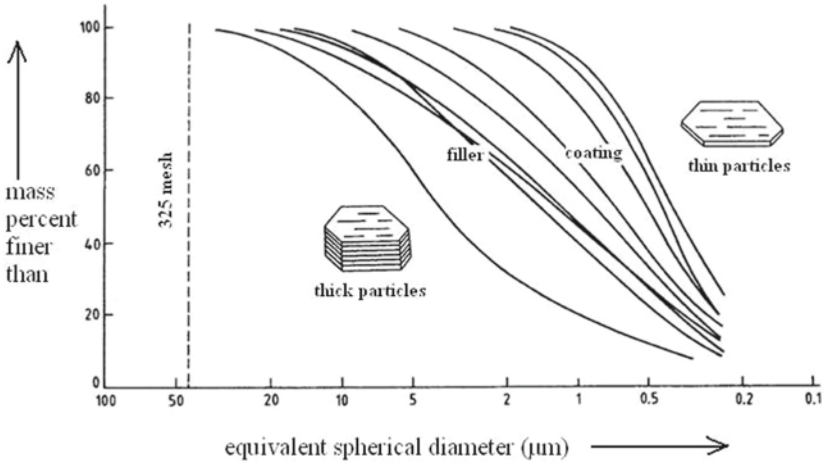

Fig. 9.1: Kaoline particle size, particle size distributions of clay products commonly used for paper filling and coating.
Source: Hagemeyer (1984), Pigments for Paper.

- **Fillers act in medical purpose:** These are designed for products that are counted by pieces instead of weight. These are designed for 256 small bottles, but the hopper of the filler is set up to permit scan counting of tablets or candy pieces.
- **Positive Displacement Pump Fillers:** Positive displacement pump filling machines easily handle a wide range of container sizes, fill volumes and product types. While originally designed for filling creams, gels and lotions, these fillers also handle water thin and heavy paste products.

QUESTIONS

1. Using adsorptive properties, explain the application of clay minerals in medicine.
2. How do microorganisms help in producing medicines.
3. In aesthetic medicines, what is the usefulness of clay minerals.
4. What is the relation between clay families and industries.
5. Describe the uses of fillers.

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