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Review

# Therapeutic potentials of bioactive compounds from mango fruit wastes

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ABSTRACT

*Background:* Continues spread of infectious diseases which affect almost 50, 000 people every day have become a leading global problem and the main reason is the emergence of multi-drug resistance in bacterial strains. So this alarming condition has necessitated search of new and natural antimicrobial substances with higher bioactivity and no side effects. From the last decade, use of plant extracts as a source of bioactive components (phytochemicals) has gained wide attention against synthetic antibiotic drugs.
*Scope and approach:* The present review aimed at evaluating the bioactive components of mango kernel, their extraction, mechanism of action, anti-microbial potential and other therapeutic roles against various diseases.
*Key findings and conclusions:* Recent studies have shown that fruit's waste parts like mango peel and kernel contain a noteworthy amount of bioactive component of therapeutic worth. These biologically active components include mangiferin, flavonoids, catechin, phenolic acids, gallic acid and gallic acid derivatives. The therapeutic importance of these compounds have evaluated through in-vitro and minimal pre-clinically but there is need to proper pre-clinical trials and afterward clinical trials for health claims and health benefits.

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## 1. Introduction

Mango (*Mangifera indica* L.), a member of Anarcadiaceae family, have more than 70 genera, and 1000 varieties, is considered one of the most important tropical fruits (Fowomola, 2010; Kansci, Koubala, & Mbome, 2008; Kittiphoom, 2012; Kobayashi et al., 2013). Dates back in 4000 years ago, South-East Asia is thought to be the origin of this delicious fruit which is now being cultivated in more than 90 countries throughout the world (Diarra, 2014). After bananas, Mango is ranked as the third most integral tropical fruit crop where its cultivation accounts for 39 million tonnes in 2010. Mexico, Indonesia, India, Pakistan, Brazil, Philippines, Nigeria, and Egypt are top mango producers. In the market of South Asia, the predominant producers are India and Pakistan (Diarra, 2014). Because of its exotic flavour, succulence, and sweet taste mango is known as the king of fruits and is broadly utilized by consumers in all stages of maturity throughout the world (Kittiphoom, 2012). Apart from consumption as ripe fruit, mangoes are processed into several frozen, canned, dehydrated, concentrated and dried products prepared mainly from mango pulp. Juices, puree, leather, squash, nectar, pickles, chutney, jam, slices, powder and ready-to-serve beverages are some of examples of mango products having considerable demand which is increasing for both domestic and export markets (Ravani & Joshi, 2013). Besides direct consumption or industrial processing of mango pulp, significant quantities of mango fruit wastes mainly in the form of peel and seed (kernel) are available (Massibo & He, 2008). The mango seed is the major waste of mango after processing, but it is a promising source of therapeutic health benefits (Ashoush & Gadallah, 2011; Kittiphoom, 2012; Momeny, Rahmati, & Ramli, 2012). Depending on their

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different varieties, mango contains about 20–60% seed of the whole fruit, and the kernel as 45–75% of the whole seed (Maisuthisakul & Gordon, 2009). Peel is a waste product of mango processing industry consisting 15–20% of mango weight (Massibo & He, 2008) (see Table 1).

Mango contains congregation of several bioactive compounds and has been used as an important herb in the traditional and Ayurvedic medicinal system, since centuries (Shah, Patel, Patel, & Parmar, 2010). These important compounds are distributed in various concentrations in different parts of mango fruit like seed, peel and pulp. A number of polyphenols like alkylresorcinol, flavonols, gallotannins, xanthones and benzophenone derivatives have been reported in mango fruit waste; peel and seed kernel (Table 2) (Barreto et al., 2008; Berardini, Carle, & Schieber, 2004; Knödler et al., 2008; Massibo & He, 2008; Schieber, Berardini, & Carle, 2003). The presence of such valuable bioactive compounds in the mango fruit waste indicated that it is not a waste instead it's a coin dumped under rocks (Engels et al., 2011a, b). These so called wastes parts have many applications in the development of ethno-veterinary medicines (Alwala, Wanzala, Inyambukho, Osundwa, & Ndiege, 2010). Various therapeutic potentials of mango fruit wastes have been investigated including antimicrobial (Alok, Keerthana, Kumar, Ratan, & Chand, 2013; David & Diemert, 2006; Gadallah & Abdel Fatah, 2011; Kabuki et al., 2000; Mirghani, Yosuf, Kabbash, Vejayan, & Yosuf, 2009; Shabani & Sayadi, 2014; Stoilova, Gargova, Stoyanova, & Ho, 2005) anti-inflammatory (Andreu, Delgado, Velho, Curti, & Vercesi, 2005; Augustyniak, Waszkiewicz, & Skrzydlewska, 2005; Nakaishi, 2000; Sanchez et al., 2000), antidiabetic (Ramesh, Parasuraman, Vijaya, Darwhekar, & Devika, 2001), analgesic, immunomodulatory (Berardini et al., 2004; Sahu et al. 2007), antioxidative (Berardini et al., 2004; Nithitanakoo, Pithayanuku, & Bavovada, 2009; Soong & Barlow, 2004), anticarcinogenic (Abdullah, Mohammed, Abdullah, Mirghani, & Qubaisi, 2014; Duthie, Duthie, & Kyle, 2000; Woude et al., 2003).

Among various health benefits, antimicrobial potential of different fruits including mangoes is of particular research interest as infectious diseases cause around one-third of all mortality globally and prevail the primary source of death especially in developing countries (Akinsulire, Aibinu, Adenipekun, Adelowotan, & Odugbemi, 2007). These diseases are mostly caused by pathogenic agents particularly of microbes (*Staphylococcus*, *Bacillus*, *Salmonella*, *and Clostridium*) that are capable of being communicable to another host (Engering, Hogerwerf, & Slingenbergh, 2013). The extent of occurrence of different infectious diseases has been increasing globally (Kaur et al., 2010) due to prolonged destitution, huge migration to urban vicinities, changes in food handling, food processing technologies and food marketing systems (Racaniello, 2004). Among all the factors, food borne pathogenic bacteria have always been considered as a major cause of morbidity and mortality due to infectious diseases in humans (Djeussi et al., 2013). The significant rise is experienced in long-standing diarrheal infection because of waterborne *Cryptosporidium*, renal collapse due to food borne *Escherichia coli*, haemorrhagic colitis, middle-ear diseases from drug-resistant pneumococci and pneumonia etc. It is because of the increase in bacterial cells multiplication, mutagenic character of bacterial DNA and continuous bacterial cells transformation (Daszak, Cunningham, & Alex, 2000).

In the United States, infectious diseases are reported for 25% of entire appointments to physicians, where antimicrobial agents are the second most commonly accepted class of medicines in each year. According to the World Health Organization (WHO), about 10 billion infections emerge annually (Akinsulire et al., 2007; Jones et al., 2008; Williams, 2000). The prevention and control of these diseases becomes crucial for the survival of human being (Djeussi et al., 2013). Although to manage the threat of infectious diseases, several strategies including antibiotics, oral therapies, micronutrient supplementation and other conventional methods have been in use (Di Cesare, DuPont, & Mathewson, 2002). But all these methods have some limitations such as induction of antibiotic associated diarrhea (Kremer & Zwane, 2006), increase in pathogen resistance against drugs (Ge et al., 2002; Goosens, Ferech, Stichele, & Elseviers, 2005; Mathew, Cissell, & Liamthong, 2007; Nair & Chanda, 2005; Neogi, Saumya, Mishra, & Raju, 2008; Vaghasiya et al., 2010), gastrointestinal disturbance, skin rashes, thrust and mineral imbalance in the body due to available antimicrobial drugs (Dancer, 2004).

In this scenario, exploration of natural, economical and effective antimicrobial compounds without side effects is an indispensable need of the time (Macarthur & DuPont, 2012). These situations has generated the requirement or demand to discover a novel source of bioactive compound to prevent the growth of pathogens. The use of plant based extracts as a natural treatment of microbial pathogens are certainly considered as safe with low cost and no noticeable side effects (Akthar, Degaga, & Azam, 2014). In order to generate awareness and to gather information, the present effort has been made to highlight the therapeutic potentials of bioactive compounds present in mango fruit wastes with particular reference to their antimicrobial potential for efficient, sustainable and cost effective treatment of infectious diseases.

## 2. Composition of mango seed kernel and peel

Mango seed consists of about 29% shells, 68% kernel and 3% testa (Diarra, 2014; Odunsi, 2005). The composition of mango seed kernel varies according to different varieties (Mirghani et al., 2009; Percival et al., 2006; Ribeiro et al., 2007; Rodriguez et al., 2006). Based on dry weight, 11% fat, 6.0% protein, 77% carbohydrate, 2.0% ash and 2.0% crude fibre is the average composition of mango seed kernel. Mango seed kernel is high in minerals such as sodium, potassium, phosphorus, calcium, and magnesium (Sandhu & Lim, 2007). The mango seed kernel contains 52–56% unsaturated fatty acids and 44–48% saturated fatty acids (primary stearic acid). A large quantity of essential amino acids (lysine, leucine, and valine) is also present in mango seed kernel. Bioactive components which are present in mango kernel include phytosterols (stigma-sterol, campe-sterol and also contains vitamin K), sito-sterol (β-sito-sterols), tocopherols, and polyphenols (Soong & Barlow, 2006).

Chemical composition of mango peel varies depending upon cultivar. A significant amount of total dietary fibre (45–78%), distributed into soluble (16–28%) and insoluble (29–50%) fractions, is present in mango peel (Ajila, Bhat, & Rao, 2007). Cellulose, hemicelluloses, pectin, lipids, proteins, carotenoids and polyphenols are also present in mango peel (Ajila et al., 2007). Mango peel also contain considerable amount of reducing sugars and because of the presence of reducing sugars mango peel also utilized for fermentation process, bio-energy and various value added products (Somda, Savadogo, Quattara, Quattara, & Traore, 2011). Rehman, Salariya, Habib, and Shah (2004) documented that mango peel contain a high quantity of pectin (10%–15%) and soaking process before the extraction of pectin increases its yield to about 21%. The pectin obtained from mango peel possesses better gelling property as compared to citrus peel pectin (Koubala, Kansci, Garnier, Ralet, & Thibault, 2012).

## 3. Bioactive compounds present in mango fruit waste

Ahmed, Saeid, Eman, and Reham (2007) demonstrated the polyphenolic composition by measuring the various polyphenolic components in mango seed kernel. The bioactive compounds or the

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