Chapter 1

Introduction

Ayurveda is a Sanskrit term, made up of the words "Ayus" and "Veda." "Ayus" means life and "Veda" means knowledge or science. It is the science of life and longevity, which is the oldest healthcare system in the world, sprouted in the pristine land of India about 5000 years ago, and it combines the profound thoughts of medicine and philosophy. It is a complete naturalistic system that depends on the diagnosis of body's humours like Vata, Pitta and Kapha. Charaka Samhita was written around 900 BCE and contains 341 plant based medications, which is considered as the first treatise with respect to Indian Ayurveda. About 395 medicinal plants and 57 animal-derived products were described in Sushruta Samhita (Dev, 1999). Ayurveda also has treatments for specific health problems. The ideas from Hinduism and ancient Persian beliefs had laid the foundation of Ayurveda. The aim is to protect health and prolong life ("Swasthyas swasthya rakshanam") and to eliminate diseases and dysfunctions of the body ("Aturasya vikar prashamanamcha") (Thakar, 2015). “Food is our Medicine” is an important concept in Ayurveda, which can prevent and eradicates the diseases.

1.1. Plant as source of antimicrobials

Plant based medicines, which is the most eco friendly system of health care, get its roots too deep in the Indian culture. Native plants have served as a key source of drugs for centuries. The Indian subcontinent is an enormous storehouse of medicinal plants that are used in traditional medical treatments (Pandey et al., 2013). For developing novel drugs, plants have provided potential insight as they were used conventionally for the wellbeing of human beings (Maurice et al., 1999). Natural products as a mean for both medicinal and health purposes were noticed throughout the course of, and evolution. Based on the ancient belief, which says that plants are created to supply man with food and proper health, man relied on the curative properties of medicinal plant, prior to the introduction of chemical medicines (Ji et al., 2009; Ahvazia et al., 2012). Traditional medicine and therapies is the main root of developing new novel compounds with therapeutic values, though the accepted modern medicine has gradually evolved by the scientific and observational hard works of many scientists (Bhushan et al., 2004).
Secondary metabolites (also referred to as natural products, phytochemicals or specialized metabolites) are the products of metabolism which are not essential for normal growth, development or reproduction which serve to meet the secondary requirements of the producing organisms. They also make the organisms potent to overcome interspecies competition, provide defensive mechanisms and facilitate reproductive processes (Vaishnav et al., 2010). Plants which are immobile autotrophs, have to tackle a number of ruthless situations which includes their own pollination and seed dispersal, fluctuations in the availability of the simple nutrients for the survival, and the coexistence of herbivores and pathogens in their micro environment (Kennedy et al., 2011). To withstand the biotic and abiotic stresses, plants have adapted by diverse ways which is reflected at the phytochemical level results in the production of numerous specialized secondary metabolites (Cox, 1994), like saponins, tannins, alkaloids, alkenyl phenols, glycol-alkaloids, flavonoids, sesquiterpenes lactones, terpenoids and phorbol esters provides the valuable medicinal properties to the plants, which help to withstand the biotic and abiotic stresses (Tiwari et al., 2004; Kliebenstein et al., 2012). At the time of infection, the host response of plants activates various secondary metabolite pathways results in the production of compounds with antimicrobial properties (Bednarek, 2012). Secondary metabolites play protective roles like antioxidant, free radical-scavenging, UV light-absorbing, and antiproliferative agents and defend the plant against microorganisms and also are active as allelopathic defenders (Harborne, 1993; Wink, 2003; Tahara, 2007). Feeding deterrence also results in the synthesis of phytochemicals which are bitter and/or toxic to herbivores (Rattan, 2010).

1.2. Cross-contamination associated with food contact surfaces

Attachment of pathogenic bacteria to food contact surfaces and the successive biofilm formation stand for severe challenge to the meat industry, as these may lead to cross-contamination of the products, which results in lowering the shelf life and transmission of diseases (Giaouris et al., 2013). Food borne pathogens such as Salmonella enterica, Listeria monocytogenes and Escherichia coli, along with common meat spoilage bacteria grow mostly as biofilms on food processing surfaces (Frank, 2001; Lindsay et al., 2006). The resistance of biofilm cells against antibacterial compounds is drastically increased (Costerton et al., 1999; Mah et al.,
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2001; Gilbert et al., 2002) and is believed that biofilm formation enhances the capacity of foodborne bacteria to survive stresses that are commonly encountered within food processing (Kumar et al., 1998; Moretro et al., 2004; Brooks et al., 2008; Giaouris et al., 2012). Although food spoilage and deterioration results in vast economic losses, food safety is a major priority in today's globalizing market with worldwide transportation and consumption of raw, fresh and minimally processed foods (Shi et al., 2009). The major challenges for food safety and quality includes the demand for minimally processed, ready-to-eat ‘fresh’ food products, globalization of food trade, and distribution from centralized processing. Packagings have a vital role to maintain the nutritional and microbial quality of fresh or fresh-cut produce (Opara et al., 2013). Packaging protects the food products, serves as an alternative measure for controlling diseases and provides structural support for convenient storage and transportation purposes. This plays a significant role in extending shelf life of food products and reduces the risk of food borne pathogens (Smith et al., 2005; Opara et al., 2013). The changes to food production practices, environment, and increase in international trade of food and alterations in the genetic characteristics of the relevant pathogenic microorganisms generate new risk in food safety (Appendini et al., 2002).

A continous commercial pressure is now generated to use synthetic preservatives for increasing the shelf life of food. The permissible limit for preservatives varies between countries, but use of preservatives is increasing and was negatively perceived by consumers (Sultanbawa et al., 2011).

The major concern among food based industries with meat production and processing is the ability of bacteria to attach with non living surfaces and the development of biofilms (Chmielewski et al., 2003). The adhesive properties of fimbriae to animal, plant and fungal cells have been early described (Duguid et al., 1966) and the uncleaned surface also enhances the survival of bacterial biofilms. The three main components which favours the attachment and development of biofilms are the bacterial cells, the attachment surface and the surrounding medium (Van Houdt et al., 2005, 2010; Palmer et al., 2007; Giaouris et al., 2009). Due to the electrostatic repulsive force, the negative charge of most of the bacterial cell surface inhibit the cell from adhesion towards the surfaces, but the hydrophobicity due to the presence of fimbriae, flagella and lipopolysaccharide (LPS) (Di Bonaventura et al., 2008; Takahashi et al., 2010) enables the cell to overcome repulsive forces and attach (Donlan, 2002). The properties of the attachment surface (e.g. roughness, physico-
chemical stability, resistance to corrosion) are also important factors that affect the biofilm formation potential and thus determine the hygienic status of the material (Rodriguez et al., 2008; Tang et al., 2011). The factors which enhances the cross-contamination includes composition of food, the texture and physicochemical properties of contact surfaces, speed–size–sharpness–material of the cutting blade, the cutting force, the slicing speed the microorganism and ultimately the environmental conditions. The meat composition plays an important role during transfer, especially the moisture and fat contents which affect the cut surface texture of the ham (Vorst et al., 2006).

1.3. Disinfectants and its effects on food processing units

For sanitising the food/ meat processing contact surfaces, cleaning and disinfection procedures which uses both physical and chemical methods were widely used over the years and was recognized that microorganisms attached to those contact surfaces are more resistant to the disinfectants than the free living ones (Mah et al., 2001; Gilbert et al., 2002). Cleaning and disinfection are carried to generate safe products with adequate shelf life and quality. To ensure that the foods produced and consumed are as free as possible from microorganisms that can cause food borne illness, chemicals are usually used to sanitize and disinfect the product contact surfaces, in the food industry / slaughter houses. Disinfection means to permanently inactivate specific infectious fungi and bacteria, but not necessarily the spores, on hard surfaces which include bactericides, fungicides, virucides, mycobactericides, tuberculocides, sporicides, sterilants or any combinations. The principle of Sanitization is to reduce microorganisms of public health concern to levels which were considered safe, without adversely affecting either the quality of the product or its safety (Pfuntner, 2011).

Fats and proteins are mostly present in the contact surface of slaughterhouses, and on the application of detergents these smears of protein and fat mixes with the detergent residues. If the cleansing procedure is irregular and the use of wrong detergents, the surfaces will develop this type of waxy mass which were not soluble in alkaline or acid solutions. The major negative aspect in concern of using chemical disinfectants includes the corrosion of the contact surfaces and the development of resistance towards these sanitizers / disinfectants. When exposed to strong alkaline, acid and chlorine solutions for extended periods, the contact surfaces will undergoes
corrosion (Wirtanen, 2014). The resistance includes innate, apparent or acquired. The development of resistance is mostly caused by innate factors (Russell, 1997), as most sanitizers are non specific in their action. The potential mechanisms are the development of impermeable cellular barriers preventing penetration of the sanitizer, cellular efflux, lack of a biochemical target for antimicrobial attachment or microbial inactivation and Inactivation of antimicrobials by microbial enzymes (Bower et al., 1999; Davidson et al., 2002). The toxicity of disinfectants and the backing of resistance to those agents in foodborne microorganisms were some of the draw backs associated with the recent sanitation processess (Heir et al., 1999; Langsrud et al., 2004; Moen et al., 2012).

The antibiotic resistance in bacteria is another serious universal threat in healthcare today and can occur in a significant minority of infected patients and predominantly for the one who have other basic health conditions, regular hospitalizations, or frequent exposures to antibiotics (Hooper et al., 2012). 'Antimicrobial resistance: no action today, no cure tomorrow’, which is the theme of World Health Day 2011 point out towards the severity of antibiotic resistance. The treatment of bacterial infections is increasingly complicated by the ability of bacteria to develop resistance to antimicrobial agents (Tenover, 2006). Multidrug resistance due to the expression by bacteria of an efflux pump is a rising clinical problem. Gram-negative bacteria have inherent multidrug resistance to several antimicrobial compounds due to the presence of efflux pumps (Piddock, 2006). Frequent and improper use of antibiotics in the treatment of human as well as animal production system has resulted in the selection of drug resistant mutants.

Drug resistance among bacteria is of concern among health practitioners as the infections caused by them are difficult to treat. Since the discovery of new antibiotics is not keeping pace with the emergence of drug resistant mutants, alternative options are being sought to reduce the selection pressure for drug resistant mutants in the environment. While prudent use of antibiotics is one important step, other step being the screening of plant based alternatives that have antibacterial activity.