CHAPTER 2

LITERATURE REVIEWS

Rice

Rice is excessively produced in the world these days. Rice farmers need to produce rice which satisfies customer’s demands. Aromatic rice, which has a stronger aroma than ordinary rice, has been very popular in South East Asia and has recently gained wider acceptance in Europe and U.S. An aromatic variety, Khao Dawk Mali 105 (KDML105), is mainly produced in Northeast Thailand. The demand for this variety is increasing in both domestic and international markets due to the appreciation of its good quality (Yoshihashi *et al*. Nodate)**.**

Khao Dawk Mali (KDML) 105 is the most popular rice variety in Thailand. This is due mostly to its pleasant aroma, which together with its white color and soft texture has resulted in its name “Khao Dawk Mali”, meaning “as white as jasmine flowers”. The name “jasmine rice” is, therefore, often used by foreign countries to refer to the KDML 105 Thai aromatic rice variety. For the past two decades, KDML 105 has become increasingly popular in many other countries in Asia and Europe and more recently in the United States. Because it is in a great demand in the rice market, Thai rice breeders have made a great effort to improve the effectiveness of aromatic rice breeding programs leading to higher productivity and yield but retaining their good aroma and texture.

A good understanding of the chemistry of KDML 105 rice, and especially of the compounds that contribute to its characteristic aroma, as well as an improved method for their quantification is considered a prerequisite for accurate detection and evaluation of aroma in rice. Since the key aroma compound of cooked rice, 2-acetyl-1-pyrroline (2AP), was first identified by Buttery *et al*. (1982), there have been a number of studies involving the identification and determination of 2AP in various rice varieties (Buttery *et al*., 1983; Buttery *et al*., 1988; Paule and Powers, 1989; Lin *et al*., 1990; Tanchotikul and Hsieh, 1991; Laksanalamai and Ilangantileke, 1993).

However, the rice crop is known to be attacked by many seed-borne diseases of major and minor importance such as *Bipolaris orysae* (Brown spot), *Fusarium moniliforme* (Bakanae disease and foot rot), *Trichoconis padwickii* (Stackburn) and *Rhizoctonia solani* (Sheath blight) etc (Maude, 1996) and by insects such as *Sitotroga cerealella* (Angoumois grain moth) *and Sitophilus oryzae* (Rice weevil) (Ebeling, Nodate; Hinds and Turner, 1911).

Pest of Rice

Seed-borne fungi

When the infected seed with *Bipolaris oryzae* is planted on a substrate, small, brown, circular or ovalspots may appear on the coleoptile, sometimes killing it, roots may also show brown to blackish lesions (Agarwal *et al*., 1989). Aluko (1975) estimated crop losses between 12 to 43%. Loss in grain weight ranging from 12 to 30%, as well as loss in filled grain from 18 to 22%, depending upon the degree of cultivar susceptibility, was recorded by Prabhu *et al*. (1980). Severely infected plants with *Fusarium moniliforme* in field develop tall tillers which are abnormally elongated and flower earlier than healthy ones, but weakly infected plants sometimes recover after transplantation (Lee, 1983) Yield losses, as high as 20 to 50%, have been reported in Japan, 15% in India, 3.7 to 14.7% in Thailand (Ou, 1985). Heavily infected seedling with *Tricochonis padwickii* eventually die, infection may reach the kernel causing kernel spot, discoloration and shrivelling (Agarwal *et al*., 1989). A number of workers have reported very high percentages of seed infection. In India, Padmanabhan (1949) recorded 51-76%, Cheeran and Raj (1966) up to 80 %, and 40-46% by Sharma and Siddiqui (1978); Reddy and Khare (1978). In a survey from 11 countries in Asia and Africa, Mathur *et al*.(1972) observed seed infection up to 80%. When severely infected with *Rhisoctonia solani*, the whole hill or part of the tiller die and fungal hyphae and sclerotia can be seen growing out of the affected parts including leaves (Gangopadhyay and Chakrabarti, 1982; Ou, 1985). In Japan, losses to the extent of 24,000 to 38,000 tons of rice occur almost every year due to infection of 120,000 to 190,000 hectares of the crop (Ou, 1985). Kosaka (1970) reported losses up to 30-40% in case of severe infection of the sheath and leaf blades.

Control of seed-borne fungi

Chemically formulated fungicides are used to control rice diseases such as sprayed Brestan (fentin acetate) + Dithane M-45 (mancozeb) in proportions of 1:5 at 0.2% at heading and grain maturation gave excellent control *Bipolaris oryzae* in India (Kulkarni *et al*., 1980). Seed treatment with Dithane M-45 and Ceresan at the rate of 0.3% of seed weight was found to eradicate infection of *Alternaria padwickii* as recorded by the blotter tests in the laboratory (Dharam *et al*.,1971). Dry seed coating with benomyl or benomyl-T 1-2% fungicide solution for 1 hour or a 1:2000 solution for 5 hours gives good control for *Fusarium moniliforme* (Ou, 1985). Seed treatment with Arasan (Thiram 75 a.i.) or Terracoat (Quintozene 23.2% PCNB) at the rate of 100 g/100 Kg of seed can control *Rhizoctonia solani* (Marcos, 1975). Chemical seed treatment is better for controlling fungal disease, but it was found to affect seed germination and vigor (Islam *et al*., 2000).

Storage Insect Pest

Sitatroga cerealella (Angoumois grain moth) attacks grains maturing in the field as well as in storage. Infested grain in storage has a sickening taste and smell that make it unpalatable. Normally, only whole grain is attacked, so other grain products are safe (Ebeling, Nodate). *Sitophilus oryzae* (Rice Weevil) is a primarily pest in warm countries, and in the United States it is most important in the South. The larva feeds inside a kernel of grain in which both larva and pupa must complete their development. Both larvae and adults eat similar food, but the latter can crawl or fly about and feed on various products. They have been reported to occur on beans, nuts, cereals wheat products and grapes, and have been observed sucking the juice from apples and pears, gradually forming cavities in which they concealed themselves (Hinds and Turner, 1911).

Control of Storage Insect

There are two registered fumigants for stored food nowadays, methyl bromide and phosphine (Kells *et al*., 2001). Since methyl bromide use will be forbidden from 2015 on ward in developed countries (UNEP, 2001). The control of these insects with methyl bromide is a serious problem for export. The main drawback for methyl bromide use is contribution to the depletion of the ozone layer and it is a tremendous hazard for human health (Sánchez-Hernández, 2002). Fumigation with phosphine (hydrogen phosphide) is the major method of chemical control but the development of resistance is a potential threat to the future use of this fumigant (Mills 2001). It is necessary to search for a variable and equally effective alternative. Ozone can replace these sanitizing agents and provide other benefits (Bott, 1991; Cena, 1998; Graham, 1997)

Ozone

Ozone (O_3, molecular weight = 48) with its characteristic pungent odor is colorless at room temperature and condenses to a dark blue liquid. It is a powerful oxidizing agent. Its oxidation potential is –2.07 volts referred to the hydrogen electrode at 25°C (White, 1972; Charles, 1995; World Health Organization, 1979). Only fluorine has a more electronegative oxidation potential. It reacts with a wide variety of organic compounds. Ozone is extremely corrosive, so that materials of construction must be very carefully chosen. Pure ozone melts at a temperature of –192.5°C, boils at –111.9°C and dissolves at 0.494 ml/100 ml water (White, 1972; World Health Organization, 1979). It is generally encountered in dilute form in a mixture of oxygen or air. It is very reactive and unstable with a short half-life before it reverts back to oxygen slowly (8 sec – 50 minutes in air and 20 – 90 minutes in water). Concentrations of ozone in air-oxygen mixtures above 30% are easily exploded. Explosions may be caused by trace catalysis, organic material, shocks, electric sparks, or sudden changes in temperature or pressure (Asean Contries, 1993). Ozone absorbs light in the infrared, visible and the ultraviolet at certain wavelengths. It has an absorption maximum at 253.7 nm. Ozone content in the atmosphere in excess of 0.25 ppm is generally considered injurious to the health and 1.0 ppm in the atmosphere is extremely hazardous to health (White, 1972).

It was believed that the ozone molecule had a ring structure where all three oxygen atoms were equivalent. Electron diffraction measurements (Durant and Durant, 1970) have revealed, however, that the three oxygen atoms in gas-phase ozone form an isosceles triangle a vertex angle of 127±3°. The length of the equal sides are 0.126±0.002 nm and the base is about 0.224 nm. The oxygen atom at either end bonding of the base are not bonded to the other as can be seen in Fig 2.1, which shows the geometry and bonding of the ozone molecule.

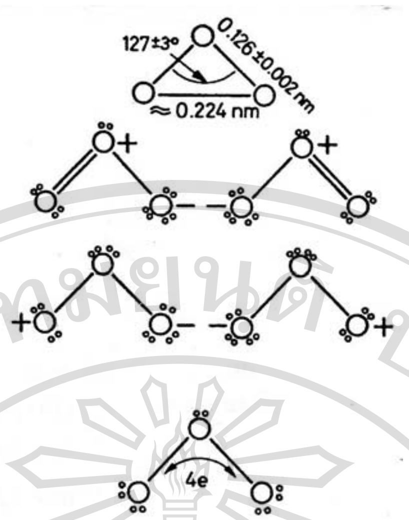

Figure 2.1 Geometry of and bonding in ozone

Chemical properties

Two basic equations for the formation of ozone are

$$3O_2 \rightleftharpoons 2O_3 \quad \text{and} \quad O_2 + O \rightleftharpoons O_3.$$

According to the first equation, the formation of ozone is an endothermic process. Thus, equilibrium between ozone and oxygen is shifted towards the ozone with increasing temperature, i.e. the relative concentration of ozone to oxygen is raised. This reaction is purely thermal. Experimental results obtained are not in complete agreement with concentrations calculated from this equation. With rising temperature, the number of dissociated oxygen molecules increase and the oxygen atoms formed thereby give rise to exothermic reaction such as

$$3O \rightarrow O_3 \quad \text{and} \quad O_2 + O \rightarrow O_3.$$

Consequently, the ozone concentration should have a maximum value at some definite temperatures.

The difference between values obtained through experiments and those determined by thermodynamic calculations is not entirely due to dissociation referred to above, because there may be inaccuracies in the measurements associated with small concentrations and high temperature.

Effect of ozone on microorganisms

Ozone is a strong oxidizing agent that has been effectively used to control fungal growth and reduce mycotoxin contamination (Kim *et al*., 1999). At low concentrations ozone protected clean surfaces from subsequent fungal contamination and growth, although higher doses were required to kill fungi on contaminated surfaces (Rice *et al*., 1982). Ozone (29 ppm) was effective in reducing or eliminating aflatoxin from cotton seed and peanut meal (Dollear *et al*., 1968; Dwarakanath *et al*., 1968). Ozone treatment also reduced the toxic effect of aflatoxin-contaminated maize fed to turkey pouts (McKenzie *et al*., 1998). Five ppm ozone inhibited surface growth, sporulation and mycotoxin production by cultures of *Aspergillus flavus* Link: Fr and *Fusarium moniliforme* Sheldon (Mason *et al*., 1997).

Effect of ozone on storage insects

Kells *et al*. (2001) evaluated the efficacy of ozone to control pests of stored grain. They reported 92 to 100% mortality of adult maize weevils, *Sitophilus zeamais* (Motschulsky), larvae of Indian meal moth, *Plodia interpunctella* (Hübner) and adult red flour beetles, *Tribolium castaneum* (Herbst) in infested maize when fumigated with 50 ppm ozone for 3 days. The same treatment also significantly reduced the viability of *Aspergillus parasiticus* (Speare) and other fungi on the kernel surface.

Effects of ozone on vegetation

Ozone in the atmosphere is harmful to certain plants and their degradation is proportional to exposure time. Plants sensitive to ozone react on exposure to 0.02 ppm for 4 to 8 hours or 0.05 ppm for 1 to 2 hours. Other oxidizing pollutants in addition to ozone, also adversely affect vegetation. At the same time, ozone can be used in the neighbourhood of plants or in a vegetal environment, e.g. for disinfection. In such as a case, its adverse effects on vegetation can be prevented if, for example, benzenedasol carbamate is also applied during disinfection (Horváth *et al*., 1985). Plants show wide differences in their sensitivity to ozone, and they can be divided into two major classes, sensitive and resistant. For examples, tobacco, tomatoes, beans, spinach, potatoes, oats, white pine, along with lilac and begonia are sensitive while mint geranium, gladiolus, pepper and the maple tree are resistant.

Damage to plants is manifested primarily on the leaves as ozone decomposes chlorophyll, particularly chlorophyll “b” (Nobel, 1974). On the upper surface of the leaves of deciduous trees, flecking can be caused by red spider and other insects which can be confused with ozone damage. Some of the leaf blights and other leaf flecking can coalesce and eventually result in the death of the tissue over a large surface. By knowing the relationship between time and concentration, the expected damage to plants can be determined provided that a sufficient amount of experience and data on individual species are available.