CHAPTER II

LITERATURE SURVEY

Drying is an age-old practice. Many researchers determined the practical ranges of temperature, humidity and time to employ for the flavor and color of the finished products. Samuel and troctor (1) recommended that temperatures higher than 165^{O}F were not suitable for fruits and vegetables and might be considerably less for some products. It is essential to dry food in as short a time as possible but conditions of humidity and temperature must be such that case hardening does not result. Furthermore, the physical consitions of product and its nutritive should not be injured or altered any more than could be avoided. Thijessen (2) studied the effect of drying conditions on the drying rate, physical loss of aroma, shirnkage and chemical degradation of quality.

Longans were dried at 60^{o}c using a tobacco leaf dryer at Chiang Mai Station 5(3). It took about 50-56 hours. Amorn Prachankadee (4) dried longans in a drying chamber at 60^{o}c and 50 % rleative humidity. It took about 20 hours to reduce the initial moisture content of 79.7 % to 14 %. When longans were died at 45-50 ^{o}C with infra-red ray, it took about 28 hours. Amorn Prachunkadee also analysed for the quantity of sugar and sulfur in the dried longans. The Department of Science, Ministry of Industry analysed the composition of nutritional components in fresh and dried longan (5).

Lurngchit Potichareon (6) studied the drying of bananas in hot air and analysed the composition of nutritional components in dried banana. Kasat Thavesat (7) studied the process of drying bananas in hot air and the effect of sulfur on the quality of dried bananas. A discussion of the effects of hot air temperature on the quality of dried bananas was given by Pitoon Praditwakin (7).

Experimental results for the initial phase of the falling rate period of avocado drying were studied by Alzamora and co-workers(8). They calculated the diffusion coefficient, then used the empirical drying behaviour to solve the energy balance equation and predict the temperature evolution of the sample during drying. Jamil(9) described the essential feature of a drying plant, the preparation of fruits and vegetables prior to dehydration and the operation of the dehydrator for typical runs. Processing of various vegetables, the quality and shelf-life of dehydrated products, plant capacity and investment were also mentioned.

Ikramov and Ismailov(10) studied the drying of grapes, which had been submerged prior to drying for 3-5 sec in boiling 0.5 % NaOH solution to make their peels burnt. Experiments were carried out in a convection drier at 50, 60, 70 and 80^{o}c and an air velocity of 1 to 3 m/sec. The product had a moisture content of 14.75 % and contained 78.9 % sugar and 1.28 % acid. They also found that solar dryer has a number of disadvantages and a temperature more than 70^{o}c was unsuitable due to darkening of raisins and shrinkage of the skins. Ponting and McBean (11) investigated the effect of dipping on the drying rates of several types of fruit. They determined the best procedure for dipping and the effect of drying temperature on the drying rate and drying time for both dipped and undipped fruit.

Exarchos (12) reviewed the technology of treating raisins and discussed the preservation of raisins in connection with changing characteristics during storage, including crystallization of sugar, moth infestation and changes in colour. Treatment and standardization of the final product was discussed under the headings: washing, drying, treatment with SO_2, cooling, removal of stalks and grading, as practised in different countries. Sjostrom and Kosa (13) studied the effects of drying grapes beneath a transparent PVC film tent under the sun. They found that dipping in an oil/KOH emulsion increased, the drying rate 1.9 times on the average and discussed the effects of KOH and oil contents of the dipping emulsion. Ziemke(14) described how Golden raisins were produced by mechanical drying (rather than sun drying) after being treated with a 0.25 % caustic solution to dissolve the skins, and SO_2 fumigation to preserve the colour. Insect attack on stored raisins was prevented by aluminium phosphide fumigation. Two-three months' storage was possible at temperatures lower than 45^{o}F without any control of relative humidity. Detailed nitritional components and composition of raisins were also tabulated. Kremnev (15) reported how grapes were predried for 3-4 hours with 3.5-5 m/s air at $30\text{-}50^{o}$c and a humidity of 5-15 gsteam/kgair until the grapes' absolute moisture content was down to 100-120 %. Subsequent drying was carried out in 2 stages, first by blowing with air at $85\text{-}90^{o}$c and a humidity of 60-80 g/kg for 3-4 hours until the moisture content was 20-30 %, and then for another 1-2 hours with air at $70\text{-}80^{o}$c and a humidity of 5-15 g/kg until the grape moisture content reached 10-20 %.

Gee(16) studied the drying of seedless grapes with air at $45\text{-}50^{o}$c and a velocity of 750 ft/min to yield a raisin product that had a lighter colour, sweeter flavor and better sanitation than sun-dried one. The colour of raisin product could be controlled by adjusting drying time and the activity of water in and near the skin to affect the enzymic browning rate. Stafford and co-workers(17) showed that a fatty acid ester reduced the drying time of grapes by interacting with the waxy surface of the grapes and determined the transformation of ester during dehydration.

Labuza and Simon(18) studied the extent and mechanism of capillary suction flow of moisture in apple slices during air dehydration. The slices were treated with surfactant solutions either by soaking or by freeze-drying and subsequent rehydration. The results showed that in the case of surfactant rehydrated freeze-dried apples, a reduced surface tension decreased the length of the constant-rate period as well as its drying rate. However, total drying times remained essentially the same those rehydrated with only water. Surfactant treatment also yielded no difference over that of soaking slices with water.Kats(19) studied the drying of apples in a fluidized bed drier. The obtained final moisture content was 14.6 %. Graphs were presented that shows the relationships between temperature (drying time), shape and size of the dried product as well as optimum drying process parameters.

Farkas and Lazar(20) determined the osmotic drying rate of Golden Delicious apple slices under a variety of conditions. The effect of temperature (30-60^{o}c) and syrup concentration (50-70^{o}Brix) on the bench-scale drying of half-ring slices (½ in thick) in stirred baths were investigated. Confirmation of laboratory data was made in a pilot plant on apple wedges (twelfths). Data on time, temperature, concentration and weight reduction were correlated and presented in a monograph. The drying rates for pilot plant runs were also predicted from laboratory data. Rotstein and Cornish(21) discussed food stuff structures and the controlling kinetic mechanisms of water migration. Utilizing a chemical potential equilibrium expression, the mass and energy transport rate equations for the system were described by two non-linear partial differential equations in two dependent variable, i.e. water concentration and temperature, both of which are functions of position and time.

Maitree Thongswang and co-worker (22) designed and constructed a laboraiory grain dryer. Hot air was blown through a prototype of 1X1 ft^2 floor area and 3 ft depth. The air flow rate was set by adjusting the inlet opening of the blower, whereas its temperature was controlled by an on-off heater. The Division of Agricultural Engineering (23) developed a through flow grain dryer using hot air. Saiwai Singhagjen(24) studied the drying of paddy, corn, coffee and chilli in the just-mentioned dryer. Bakshi and Singh(25) measured the drying rate of parboiled rice and found no constant rate period. The drying characteristics of raw rice were discussed by Wang and Singh (26). Kachru, Ojha and Kuruys(27) investigated the drying characteristics of Indian paddy varieties. Kachru and Matthes(28) developed an equation for predicting the drying time and instantaneous moisture content of wetted rough rice during thick-layer batch drying. The equation was obtained from similitude and dimensional analysis. Yamashita and Ritsuya (29) researched on paddy drying and rice whitening in the Philippines. Bakshi(30) studied the kinetics of a rice parboiling process.

Somsak Dumrongsak(31) studied the drying rate of grain(corn, bean grain) in a fluidized bed dryer. Chaiyot Tangsathitkulchai and Taveesak Krutapun (32) claimed the effect of air flow rate and air temperature on drying rate of paddy in parboiling process.

Phole Sagethong(58) studied the drying of parboiled rice in a spouted bed and compared his results with those of other methods. Phol (59) also studied the drying of parboiled rice in a fluidized bed dryer. The result shows that fluidized bed drying can be applied to parboiled rice very effectively as well as the spouted bed. The drying of pepper and corn were claimed by respectively Somsak Arthornsombat and Ubolwan Sansanurrthayakul(33),and Adisorn Pipatawanich and Sawitree Bintasan (34). Laul and Giradkar (35) studied the drying characteristics of chillies and determined the heat and mass transfer coefficients in fluidized bed. Sepitka (36) illustrated the effects of load size, degree of comminution, air temperature and speed on the drying of potato slices and other comminuted or pelleted food materials.

Chirife (37) determined the effective diffusivity of moisture in the through circulation drying of tapioca root slices. Webb and Gill (38) and Saksin Rusmitus (39) investigated the drying characteristics of tapioca chips under varying experimental conditions, such as air temperature, velocity and bed depth . Igbeka (40) proposed a mechanism of moisture movement and determined the equilibria in the dehydration of cassava and white potato. Subsequently, Igbeka (41) simulated the movement of mosture during the drying of a starchy food product of cassava. Thanh and co-workers (42) tried to improve the drying of tapioca chips in Thailand. Babenya (43) determined the rate of drying potatoes in a stationary bed during the initial period. Naas (44) determined the drying rate of potato and carrot slices in a tunnel drier under varying experimental conditions.

Bravo and McGraw (45) investigated the fundamental drying characteristics of cocoa beans. The transfer coefficients for the constant rate period and diffusion-controlled falling rate period as well as optimal drying conditions for cocoa beans were determined by Jacquet and co-workers (46). Gangopadhyay and Chaudhuri (47) compared the dehydration of pricked and unpricked peas in a fluidized bed and a conventional tray drier.

Kubota and co-workers calculated the drying rate of agar gel spheres and carrot spheres using a drying-shell model (48) and a uniform drying model (49).

Many researchers have studied drying of agricultural products (cereal grains). However, published information on the drying characteristics of common Thai agricultural fruits and classification of type of materials according to drying characteristics are still lacking.