

THIN-LAYER DRYING OF MARIGOLD FLOWERS
AND FLOWER COMPONENTS
FOR PETAL REMOVAL

By

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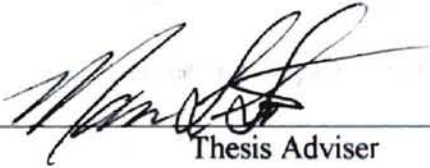
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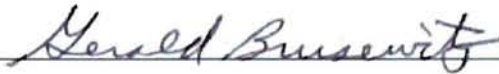
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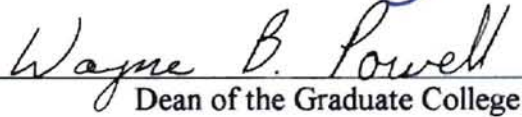


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CHAPTER I

INTRODUCTION

During the last one hundred and thirty years, public concern has developed over the potential side effects caused by artificial food coloring. Counsell (1981) defines artificial food colors as those which do not occur as such in nature or in our daily food and are only manufactured synthetically. As early as 1857, chemical analysis proved that certain artificial food colors contained lead chromate, copper chromate, copper arsenic, and other harmful chemicals. Years later these chemicals were shown to cause cancer, brain tumors and hyperactivity in children (Winter 1979). Based on color additive studies, the United States has banned many artificial colors, however several remain such as Yellow No. 5 and Yellow No. 6, which are derived from coal tar and petroleum by-products. Every day individuals consume candy, carbonated beverages, dairy products, and many other products that contain artificial colors.

The growing consumer concern over use of artificial food colors is driving the search and production of "natural" food colors (Walford 1980). Counsell (1981) defines natural colors as those which occur naturally in our food and are produced either by extraction or synthetically. The search and production of natural food colors affects many of the products consumers purchase every day, such as poultry and dairy products. For example, chicken skin and egg yolks from chickens raised in the traditional farm setting are more yellow than those produced from commercial poultry operations. To minimize the color difference, commercial producers supplement chicken feed with an additive containing xanthophyll pigments that result in a more traditional coloring of the

egg yolks and chicken skin. Xanthophyll is a natural yellow-orange colorant found in most plants although the content varies widely from plant to plant. Marigolds (*Tagetes erecta*) are plants whose flower petals, for certain orange retailed varieties, contain a large amount of the xanthophyll pigment. The xanthophyll extracted from marigold petals is currently used in a few commercial food products, such as the feed additive for chickens and colorant for dairy products. The demand for the natural yellow-orange colorant produced by the xanthophyll pigments will increase as manufactures continue replacing artificial colors with natural colors.

As the demand for xanthophyll extract increases, producers and manufactures will demand a higher quality product and more cost-effective process respectively.

Xanthophyll losses, associated with processing, are a significant problem. Research has shown that the main reason for pigment loss is instability. Xanthophyll pigments are especially sensitive to light, heat, and oxygen (Davies and Kost, 1988). Each of these factors contributes to the quality losses in the current processing of marigolds.

The current commercial processing of marigolds is achieved through the following steps: hand picking the flowers, storing, drying the flowers, and processing the dried material in a pelletized form for extraction. After harvesting, the plant material is generally stored outside for several days or even weeks before drying. Prolonged exposure to light and heat causes a significant reduction in xanthophyll quality and quantity (Davies and Kost, 1988). In addition, the wet material is increasingly susceptible to mold growth over time, which reduces xanthophyll quality. Drying the plant material at high air temperatures can also degrade the xanthophyll content. After drying, the dried material maybe processed into the form of pellets or extract. The

quality of these products is further reduced by the presence of green material and seeds found in the dried material.

Biosystems and Agricultural Engineering and Horticulture and Landscape Architecture Departments at Oklahoma State Universities have proposed methods for processing marigolds which focus on minimizing the storage of the harvested material, optimizing the drying process, and reducing the quantity of green material and seeds in the final product. This new process consists of four steps: mechanically harvesting the flowers, drying the flowers, detaching the petals from the remainder of the flower (the receptacle), and extracting the xanthophyll pigments from the petals components. After harvesting, the material is dried in a forced air system. Drying the wet material rapidly to a region where the petals become brittle and the receptacles remains flexible would reduce the mechanical work required in separating the petals from the receptacle. Xanthophyll is then extracted from the petal material. Optimizing the drying parameters, to maximize petal detachment, will ultimately increase the processing efficiency and increase the quality of the end product.

The drying of marigolds, like hops and peanuts, may take place in deep bed dryers. Deep bed drying can be simulated by dividing the bed depth into finite thin layers and assuming that the conditions of the air leaving one layer are the same as the conditions of the air entering the succeeding layer (Troeger and Butler, 1979). By determining the characteristics of a single layer, a deep-bed drying model can be developed.

Thin layer modeling is typically used in determining the drying rates of a single layer of material where the air conditions entering the layer are essentially the same as

those exiting the layer. Four variables having major effects on drying rates for a given sample of material are: air temperature, airflow rate, relative humidity, and drying time. By conducting thin layer-drying tests at various air temperatures and airflow rates, then developing a thin layer model, the change in the moisture content of the flower components can be characterized.

The main purpose of this study was to perform thin-layer studies to determine the drying characteristics of marigold whole flowers, petals, and receptacles. Additional objectives include determining the effect of drying conditions on petal detachment and xanthophyll content. The results of this proposed study will provide valuable information needed to optimize the marigold drying process for xanthophyll production.

CHAPTER II

LITERATURE REVIEW

Food Coloring Background

The practice of food coloring dates back to early times. In the days of the Roman Empire, Pliny reported that wine and bread were frequently colored with items such as fruit berries (Walford, 1980). The coloring of food has evolved from these early times into a huge industry. Today, practically all manufactured foods, prescription drugs, and some natural foods include food coloring.

Counsell (1981) suggests that a great deal of psychology is bound up with color. People associate certain colors with anticipated responses such as red to danger or green to safety. The following example demonstrates how this correlation pertains to food products: holiday guests might have doubts about eating a green ham, while a pink ham might be devoured before the second helping. A consumer's impulsive response to certain colors has many advantages, such as product selection, for the food, beverage, and drug industries.

In nearly all food, beverage, and pharmaceutical industries, the colors, color combinations, and color uniformity of products is very important. Use of food color additives can produce products that are more acceptable to consumers. Walford (1984) suggest that meals with several different colors can create a pleasant experience and enhance the appetite. The natural colors of canned fruits and vegetables become unstable after harvest and fade during processing or in storage. By adding colorants, the product

becomes more acceptable to consumers. In the pharmaceutical industry, color added to prescriptions reduces the chance that patients confuse different medications. Color can also make a pill more attractive and therefore easier to take (Kropf and Houben, 1980).

Artificial Food Colors

For many years, artificial organic colors have been considered the most economical, reliable, and safest method of food coloring. Since the discovery of dye synthesis, artificial colors have extensively replaced natural colorants due to their superior consistency of color, strength, color range, brilliance of shade, stability, ease of application, and cost effectiveness (Walford, 1984). Stability is a primary issue in commercial food coloring. Artificial colors are normally sterile when manufactured and will remain stable for years if they are sealed in containers and stored in a cool dry environment. However during food processing the stability can be affected by ultra-violet light exposure, processing temperatures, alkalis, acids, reducing agents, oxidizing agents, and protein levels.

Since the 1960's, safety questions about the use of artificial food colors have increased. Artificial colors are typically composed of coal tar or petroleum by-products. These by-products include toluene, naphthalene, anthracene, aniline, and other aromatic hydrocarbons used in artificial colorants. Winter (1979) concluded that any product derived from coal tar must be suspected of causing cancer, including dyes. Of the group of eighty food colors used in the United States one hundred years ago, there are only nine artificial food colors currently approved by the Food and Drug Administration. Winter (1979) suggests that even the approved colors are health hazards based on laboratory tests

using mice. Table I lists the approved colors and suggests the possible hazards. Kropf and Houben (1980) agree that these artificial dyes are health hazards and suggest that all artificial dyes be avoided. Further, some psychologists believe that artificial colorants can cause the symptoms that lead to hyperactivity in children.

Table I: A summary of potential hazards due to artificial food colors.

Artificial Food Color	Health Hazards
Blue No. 1	Malignant tumors at the site of injection
Blue No. 2	Cancer
Green No. 3	No information
Red No. 3	Tumors and bladder cancer
Red No. 40	Tumors and bladder cancer
Yellow No. 5	Allergies, tumors, and cancer
Yellow No. 6	Allergies, tumors, and cancer
Citrus Red No. 2	Kidney damage, circulatory collapse, and cancer
Orange B	No information

Feingold (1968), noted that practically all the bodily systems can be affected by artificial colors: respiratory symptoms such as allergic rhinitis, nasal polyps, cough, laryngeal edema, asthma; skin reactions such as pruritus, dermatographia, and angioedema; and neurologic symptoms such as headaches and “behavioral disturbances” (Conners 1980). Feingold hypothesized that a diet free of artificial colors and flavors would improve the behavior in “hyperactive” children and reduce individual chances of respiratory and neurological problems (Rowe and Rowe, 1994; Conners 1980). Several studies have been conducted to prove the validity of Feingold’s hypothesis. These studies have been performed on children diagnosed with hyperactive symptoms, resulting in small sample sizes. Double-blind, placebo-controlled, and repeated-measures studies

have shown that a diet free of artificial food colors can reduce a child's hyperactive symptoms. However due to the sample sizes, no conclusions can be drawn on how artificial colors affect the general population (Rowe and Rowe, 1994).

Although studies have shown that artificial food colors pose health risks, the production of artificial colors has become a large industry. A wide range of secondary colors has been developed through the blending of the approved primary colors. In addition, water-insoluble pigments called lakes have been manufactured (Walford, 1984). These products have assisted in the growth of the artificial color industry, not only in the United States but also around the world. In 1982, the worldwide consumption of artificial food colors exceeded 7,500 metric tons (Walford, 1984).

Natural Food Colors

Natural coloring materials of plant, animal, and mineral origin have been added to food products for centuries. The main groups of natural coloring substances in food are carotenoids, anthocyanins, porphyrins, and chlorophylls. The carotenoids are responsible for many of the brilliant reds, orange, and yellow colors of edible fruits and berries, vegetables and mushrooms, flowers, and some animals. They occur widely in nature, and it is thought that the annual natural production of these compounds exceeds 100 million tons. (Counsell, 1981)

The carotenoids have been successfully incorporated into specific products, but carotenoids offer neither the range of color nor the stability of artificial dyes (Walford, 1980). The main problems associated with work on carotenoids arise from the inherent instability of the pigments. They are especially sensitive to light, heat, oxygen, acids, and

in some instances to alkali. In addition, they may be destroyed by enzymatic oxidation, which plays a role in the decay of vegetable matter. Other problems include low solubility and high processing costs. The chemical and physical properties of pure carotenoids are particularly significant when considering these products as food additives. Although many of the natural pigments presently available are unsatisfactory for one reason or another, researchers are attempting to improve the quality and quantity of natural food colors by various means. One approach has been to search the plant, animal, and microbial kingdoms for pigments that are stable under conditions prevailing in foods.

Forthcoming regulations will tend to restrict the use of food color additives exclusively to natural compounds (Minguez-Mosquer et. al., 1993). The Food and Drug Administration is responsible for regulating all color additives used in the United States. This agency classifies all permitted color additives as certifiable or exempt from certification. Colors exempt from certification include pigment derived from natural sources such as vegetables, minerals or animals, and man-made counterparts of natural derivatives. These colors are subjected to rigorous standards of safety prior to their approval for use in food. Whether a color additive is certified or exempt from certification has no bearing on its overall safety.

Xanthophyll

The Carotenoids are one of the most important groups of natural pigments used as food colorants. The group encompasses both the hydrocarbon carotenes and the oxygenated xanthophylls. Carotenoids are responsible for most of the yellow, orange and red shades in living organisms. Xanthophyll may be obtained through solvent extraction

of the petals or leaves of a number of different species of plants, including *Tagetes erecta* L. (Marigolds) (Davies and Kost, 1988).

Tagetes extract is currently obtained through the hexane extraction of dried *Tagetes erecta* L. petals. The main coloring principle of the extract consists of xanthophyll (oxyderivatives of carotenes) and the primary pigments are palmitate esters of lutein, particularly dipalmitate lutein (helenien). *Tagetes* extract may also contain fats, oils and other waxes naturally occurring in the plant material. This orange oil-soluble extract is currently used in dairy and fat-based products, and as an additive to poultry feed. (JECFA, 1992)

Marigolds –*Tagetes erecta* L.

The common names for *Tagetes erecta* are American Marigold, African Marigold, Big Marigold, or Aztec Marigold. They are a genus of annuals that flower continuously from early summer to autumn frost. Marigolds tolerate dry conditions, but prefer moist, well-drained soils. Extreme heat in the summer lowers the pigment quality of the marigold. Insects or diseases seldom bother these plants, but slugs, spider mites, Japanese beetles and Aster yellows occasionally cause problems.

Tagetes erecta are fast growing, erect brushy plants, which have aromatic, feathery, glossy, deep green leaves and large daisy like blossoms in shades of yellow and orange. These marigolds typically grow to heights of one meter. The flower heads are solitary and range from 7 to 13 cm in diameter. A marigold schematic is shown in Figure 1. (Still, 1994)

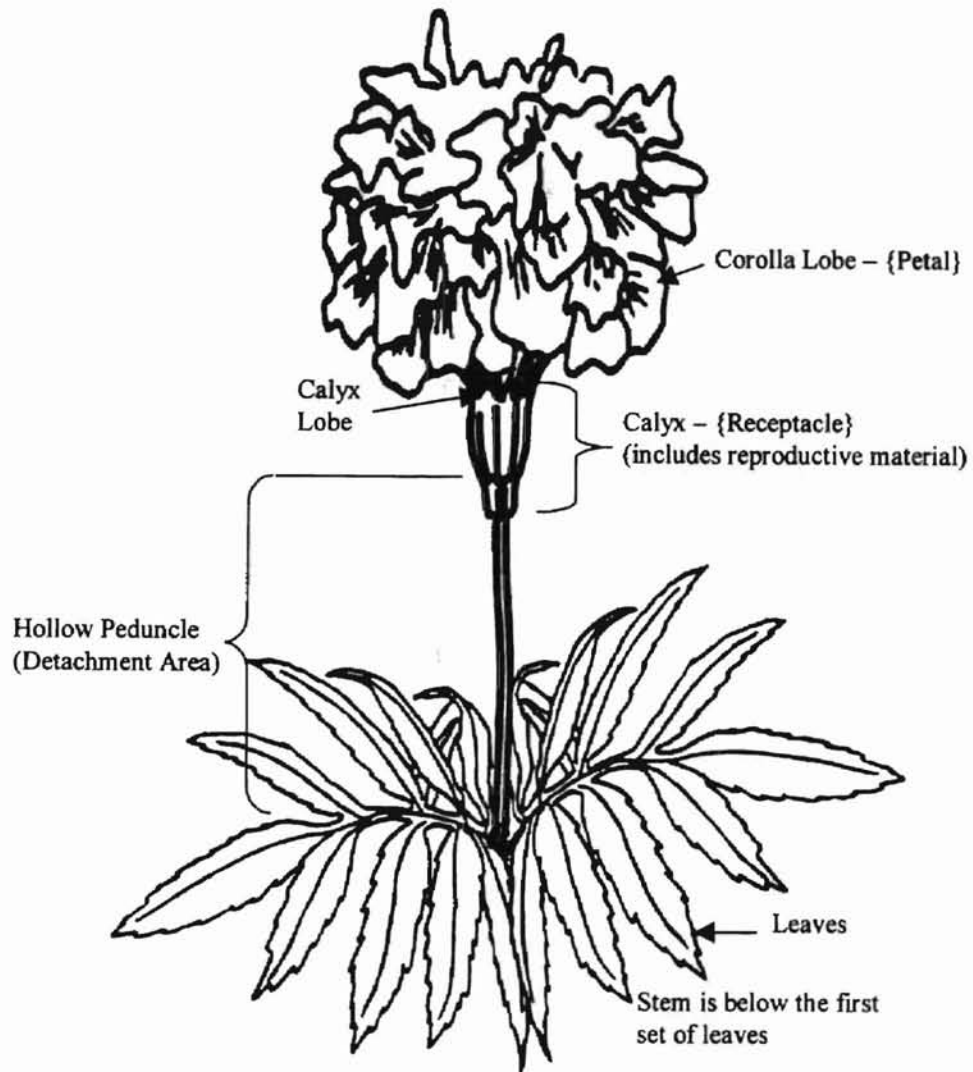


Figure 1: Marigold Schematic.

The flower yield is typically increased when the mature flowers are removed. In 1997, Maness (1997) reported dry-petal yields of 947 pounds per acre for Orange Lady marigolds grown on 0.1 acre plots in Stillwater, Oklahoma. Dry-petal yields for A975, X986, E-1236, and I822 marigolds were 1188, 482, 1760, and 783 pounds per acre respectively.

Marigold Drying Facility at Los Mochis Mexico

Marigolds for xanthophyll extraction are primarily grown and processed in Mexico, Peru and India. Stone and Kranzler (1988) stated that the processing procedures at a Mexico processing plant consisted of storing the harvested material, pressing, drying, and grinding the plant material. Once marigold flowers were transported to the facility, they were stored in the open air on a concrete slab. Then the flowers were prepared for drying by pressing the plant material to remove water. The pressed material was then dried with heated air. After drying, the material was ground into a meal by hammermills, pressed into a pellet and extracted with hexane at another location.

The dryer had eight 12 m x 8 m drying floors and was configured in a deep-bed updraft arrangement with two oil-fired furnaces providing 140-160 °F air to the bed. During the drying process, the temperature varied as result of the changing airflow rate. The bed depths were approximately one foot. Drying times were approximately 16 hours, with about 8 hours required for filling and emptying the floors. (Stone and Kranzler, 1988)

Drying

Troege (1982) suggests that deep-bed drying can be simulated by dividing the total depth of the bed into finite layers. In this model drying is simulated by passing air from one layer to another in the direction of airflow. As the air moves through a layer, water evaporates from the material and causes a change in the temperature and moisture content of the air. The resulting properties of the air as it leaves one layer become the initial properties of the next layer. A thin-layer model is typically used to determine the drying rate of a single layer of material in deep-bed drying.

Researchers have developed numerous empirical and theoretical thin-layer drying models for various agricultural products (Tang and Sokhansanj, 1984). However, to date there is no published model for the drying of marigolds. Generally, these models are based on the collection of experimental thin-layer data. This data characterizes the change in moisture content and temperature of individual particles under constant drying conditions. Currently there are three primary thin-layer models: the One-term exponential model (Henderson and Pabis, 1961), Page's model (Misra and Brooker, 1980), and the Two-Term model used in products such as peanuts (Sharaf-Eldeen et al., 1980). These models are shown below in equations 2.1, 2.2, and 2.3.

One-term exponential model,

$$\frac{M - M_e}{M_o - M_e} = e^{(-K \cdot t)} \quad (2.1)$$

Page's model,

$$\frac{M - M_e}{M_o - M_e} = e^{(-K \cdot t)^n} \quad (2.2)$$

Two-term model,

$$\frac{M - M_e}{M_o - M_e} = a * e^{(-K_1 * t)} + (1 - a) * e^{(-K_2 * t)} \quad (2.3)$$

The information provided by the thin-layer models maybe used to solve mass balance equations in dryer simulations. In deep-bed models, these equations produce the water content of the material and the air as a function of time and location in the bed. These results correspond to the initial conditions of the air in the next layer and the initial conditions of the product moisture content of the next time step in the deep bed drying process. By iterating these calculations, the conditions of the air and material can be determined at any time or location within the bed. In addition, thin layer data can also be used to model cross flow, counter flow, and other dryer configurations.

Objectives

The goal of this research was to determine the thin layer drying characteristics of marigolds. The specific objectives were:

1. To determine the water diffusion rate in marigold flowers, petals, and receptacles at various air temperatures and airflow rates during drying.
2. To determine the drying temperature and airflow which produces the optimum drying endpoint for petal detachment.
3. To determine the xanthophyll content in the marigold petals after drying at various air temperatures and airflow rates.
4. To determine the optimum combination of drying and xanthophyll changes for maximum petal detachment.

CHAPTER III

MATERIALS, EQUIPMENT, AND METHODS

Marigold Flowers

The variety of marigolds used in this study was Orange Lady. Oklahoma State University's Horticulture and Landscape Architecture Department transplanted the marigolds to experimental plots at the Oklahoma Botanical Garden and Nursery complex in Stillwater, Oklahoma in May of 1996. Fresh full-bloom marigold flowers, which were required throughout the thin-layer drying experiments, were ready for harvest in late June. To reduce the chemical and physical changes caused by harvesting conditions the thin-layer drying experiments were conducted from late June to the middle of July. Mature flowers were randomly harvested by hand in early morning to avoid flower shrinkage due to environmental drying, while the over mature flowers were discarded. After harvesting, the samples were immediately transported 2 miles to the Biosystems and Agricultural Engineering Laboratory and prepared for drying.

Equipment

Drying was conducted at the Biosystems and Agricultural Engineering Laboratory. The drying study utilized three dryers, designed for thin-layer drying experiments. A schematic of the dryers is shown in Figure 2.

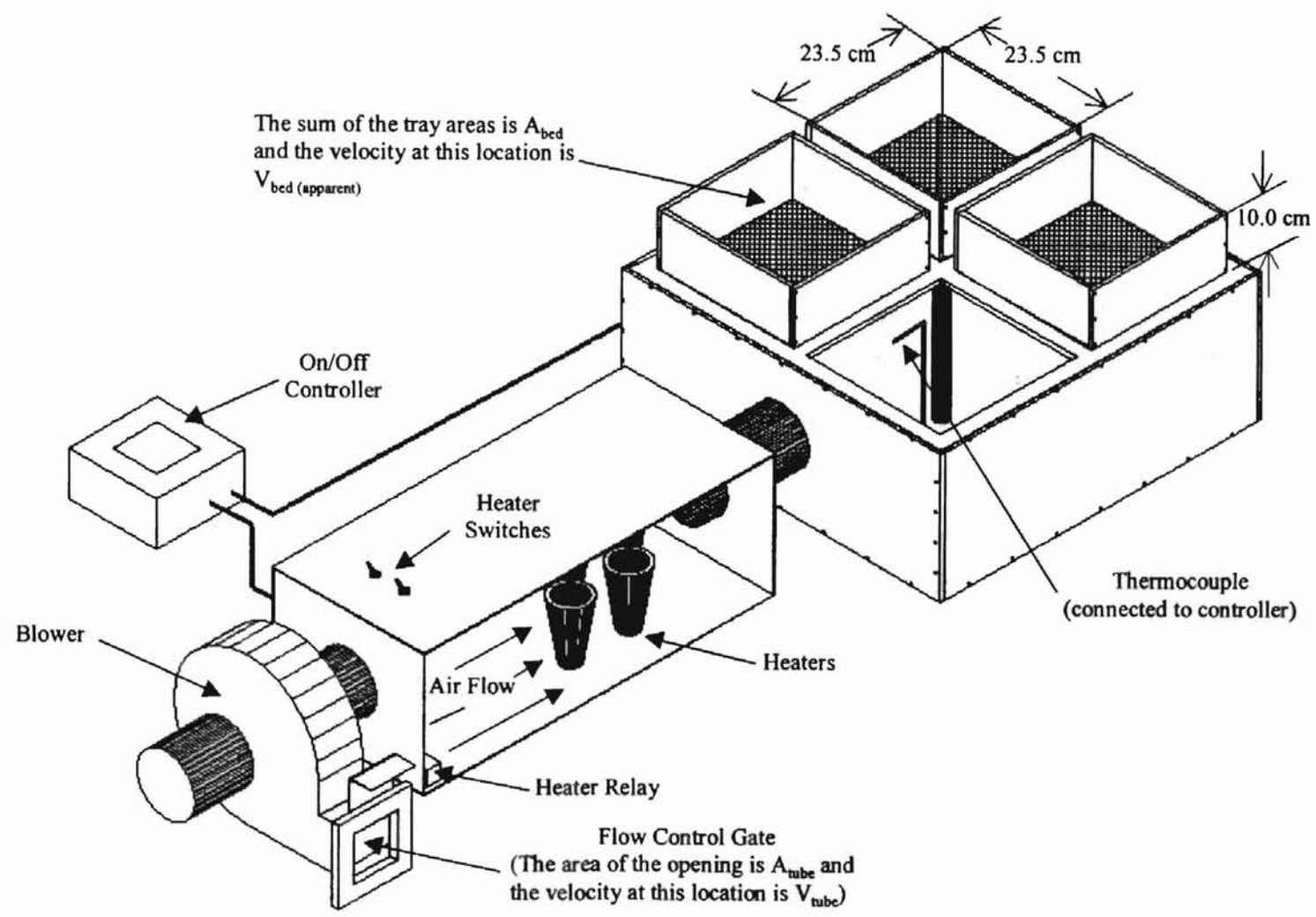


Figure 2: Dryer Schematic.

The dryers consist of a 1/25 horsepower Dayton electric blower, which was used to direct airflow across six 1,000 watt ceramic heating elements and then to the plenum under the trays. The airflow rate through the bed was controlled by a gate valve located on the intake side of the blower. As the air exited the blower, it was heated by three sets of two heating elements. The heating elements were wired through two double-pole double-throw switches and then to the controller. The switches allowed the user to control the number of heating elements used by the controller. The controller was an ON/OFF temperature controller and was used to regulate the air temperature through the plenum. This controller maintained the air temperature within $\pm 1^{\circ}\text{C}$ of set-point temperature range by using a type T thermocouple located beneath the drying bed. The drying bed consisted of four single layer trays with 4.75 mm wire mesh bottoms. Each tray has a drying area of 552 cm^2 for a total bed area of 2208 cm^2 . In addition to the dryers, two Fisher Isotemp forced convection ovens, model numbers 350 and 438F, were used to dry moisture content samples. Other equipment included: a Velocicalc Model 8357 air velocity meter with an accuracy of $\pm 0.01\text{ m/s}$ for an air velocity range of 0.15 to 2.5 m/s and a Fisher Scientific model XD-8KD scale with an accuracy of ± 0.002 grams for a range of 0 to 800 grams.

Thin-Layer Experiment

This study was designed to produce the data required to develop a thin-layer drying model. Air temperature and airflow rate through the bed were the independent variables in this study. The measured responses were the moisture content of the flower components and a qualitative measure of petal detachment ease. During a specific test,

the air temperature and airflow rates were held constant and moisture content data was collected at periods during drying. A range of different air temperature and airflow rate combinations allowed determination of the optimum drying conditions for petal detachment ease.

In addition to developing a thin-layer model, this study identified the factors that describe the drying range for petal detachment ease. A flower from each drying period was selected for petal detachment and given a physical description representing the detachment process. To simplify this procedure, a numerical value was assigned to the moisture status of the petals and receptacles (Table II).

Table II: Numerical identifiers. The qualitative measure of petal detachment ease (PDE).

PDE Code	Receptacle Description	Petal Description	Drying Process Description
1	Wet	Wet	More Drying Needed
2	Wet	Damp	Near Optimum Petal Detachment Conditions
3	Wet	Dry	Optimum Petal Detachment Conditions
4	Damp	Wet	Receptacles Drying to Fast and Petals Drying to Slow
5	Damp	Damp	Receptacles Drying to Fast and Petals Drying to Slow
6	Damp	Dry	Near the End of Optimum Petal Detachment Conditions
7	Dry	Wet	Receptacles Over Dried for Petal Detachment
8	Dry	Damp	Receptacles Over Dried for Petal Detachment
9	Dry	Dry	Petals and Receptacles Over Dried for Petal Detachment

PDE codes are based on the idea that petals detach from the receptacle best when the petals are dry and the receptacles are wet. PDE code three of Table II describes these characteristics. Under these conditions, the physical work required to detach the petals from the receptacle is minimized. In addition, the receptacle is more likely to remain intact and therefore decreases the likelihood of contamination of petal material by receptacle components.

The work associated with detaching the petals from the receptacles increases as the physical characteristics of the flower components deviates from PDE code three. When both the petals and receptacle are wet, the work required to detach the petals from the receptacle is greatly increased. When both components are dry, the work required to sort the petals from the receptacle is greatly increased. The later is due to the shattering of the receptacle caused by over drying.

The air temperature and airflow rate ranges of interest were 55°C to 70°C and 0.23 to 0.33 m³/sec·m² respectively. These ranges were selected because they represent actual ranges that maybe used in commercial processes. Temperature and airflow rate combinations were derived from four equally spaced air temperatures (55, 60, 65, and 70°C) and three equally spaced airflow rates (0.23, 0.28, and 0.33 m³/sec·m²). Three replications were performed for each temperature and airflow rate combination requiring thirty-six individual tests. Utilizing the three experimental drying beds available, three replications of the same combination were preformed in a single day.

Each thin-layer dryer had the capacity to hold 48 full-bloom marigold flowers. Therefore, 144 flowers were harvested each day of the experiment. Immediately after transporting the flowers to the laboratory, they were prepared for drying. Forty-eight specimens were randomly selected from the harvested lot, individually weighed, individually labeled, and placed into a drying bed representing one replication. This process was repeated for the second and third replications.

Preparing the dryers required setting the temperature controller and adjusting the airflow gate to the desired values. The gate was adjusted to the desired airflow rate by

using equation 3.1 and measuring the average air velocity entering the blower with the Velocicalc model 8357 air velocity meter.

$$V_{\text{Bed(Apparent)}} = \frac{A_{\text{Tube}} * V_{\text{Tube}}}{A_{\text{Bed}}} \quad (3.1)$$

In equation 3.1, A_{Bed} represents the area of the drying bed, $V_{\text{Bed(Apparent)}}$ apparent air velocity through the drying bed, A_{Tube} cross-sectional area of the blower inlet, and V_{Tube} air velocity of the air entering the blower inlet. The drying bed refers to the combined area of the four trays. The airflow through the bed decreased in the outside corners. To compensate for this problem each tray was rotated 90° and the four trays, as one unit, were rotated counter-clockwise 90° every ten minutes during drying. This procedure was intended to distribute the exposure of the flowers to variable airflow rates in the dryer.

Preliminary drying tests were conducted to determine the time delay before sampling and the sampling endpoint. The tests were conducted at the various temperatures and a constant airflow rate of 0.28 m³/sec m². Based on these preliminary tests, it was concluded that an eight hour sampling range was sufficient to achieve the objectives of this study. The time delay before sampling was determined to be 120, 150, 180, and 210 minutes for temperature settings of 55, 60, 65, and 70°C respectively.

The drying process began with placing the flowers for replication one on a dryer followed by replications two and three with ten minute delays between each replication to allow for repeated weight measurements during the study. The flower trays were rotated every ten minutes until the completion of the tests. In addition, sampling started after the time delay and continued for eight hours.

Sampling involved randomly selecting three flowers every 30 minutes from a single test bed, the three flowers refer to a sample while a single flower refers to a sub-sample. The first sub-sample was weighed and placed in a tray. This sub-sample was used in determining the drying characteristics of the whole flower. The petals of the next sub-sample were detached from the receptacle. Both components were weighed and placed in separate trays. This sub-sample was used in determining the moisture content of the petals and receptacles. The final sub-sample was separated like the second sub-sample and given a PDE code from Table II. The petals were placed in a plastic bag and stored in a freezer for xanthophyll tests. The receptacles of the third sub-sample were discarded. After the completion of the drying tests, the sub-samples in the trays were placed in a drying oven at a temperature of 120°C. The material remained in the oven for a twenty-four hour period. Then the sub-samples were removed and individually weighed. This procedure was repeated for each temperature and airflow rate combination in the thin-layer drying experiment.

The weight losses recorded in the thin-layer drying experiment were assumed to be moisture losses. Equation 3.2 was used to compute the initial and after drying dry basis moisture contents of each sample, excluding the samples used for xanthophyll analyses. These computed moisture contents form the basis for developing a thin layer model.

$$M = \frac{[W_{wet} - (W_{Dry} - tare)]}{(W_{Dry} - tare)} * 100 \quad (3.2)$$

In the initial moisture content calculations for the whole flowers, W_{wet} refers to the initial weight of the sample and W_{Dry} refers to the weight after oven drying. For the separated

sub samples, W_{wet} refers to the initial unseparated weight and W_{Dry} is the combined oven weight of the petals and receptacle. In the after-drying moisture content calculations, W_{wet} represents the recorded weight after drying minus the tare weight and the W_{Dry} is the recorded oven weight.

Thin-Layer Modeling

A theoretical model, assuming a constant drying coefficient, was developed to fit the data produced in the previous drying experiment. The simple one term exponential drying relationship, as shown in Equation 3.3, has been determined as a feasible solution in describing the thin-layer drying of many biological materials (Brooker et al., 1978). However, the model should not be extrapolated beyond the experimental conditions for which the constant drying coefficients were obtained.

$$MR = e^{(-kt)} \quad (3.3)$$

In the equation 3.3, K is the drying rate coefficient and t represents the drying time. The moisture ratio (MR) is the instantaneous moisture content (M) minus equilibrium moisture content (M_e) divided by the initial moisture content (M_i) minus the equilibrium moisture content (M_e) as shown in the following equation.

$$MR = \frac{(M - M_e)}{(M_i - M_e)} \quad (3.4)$$

This equation implies that the change in moisture content depends on the vapor pressure difference between the air and material. The equilibrium moisture content, M_e , accounts for the effects of relative humidity and temperature of the inlet air on the drying process.

The drying rate coefficients, K (hr^{-1}), were determined by fitting the data generated in the thin-layer drying experiment to equation 3.3. These values were then represented in a linear model as a function of air temperature and airflow rate. This model is shown in equation 3.5.

$$K = C_1 + C_2 * T + C_3 * V \quad (3.5)$$

In equation 3.5, T and V are the air temperature and airflow rate corresponding to the drying rate coefficient, K , and C_1 , C_2 , and C_3 are the linear coefficients obtained through regression analysis.

Measurement of the moisture diffusion rate was an objective in this study and a parameter used in developing a deep bed model. This parameter can be represented through the following mathematical manipulation. Differentiating equation 3.3:

$$\frac{d(\text{MR})}{dt} = -K * e^{(-Kt)} \quad (3.6)$$

Substituting MR for the expression $e^{(-Kt)}$ in equation 3.6:

$$\frac{d(\text{MR})}{dt} = -K * (\text{MR}) \quad (3.7)$$

Cancelling like terms, the moisture diffusion rate can be represented as

$$\frac{dM}{dt} = -K * (M - M_e) \quad (3.8)$$

Finally substituting equation 3.5 for the drying rate coefficient, the moisture diffusion rate can be expressed in terms of air temperature and airflow rate

$$\frac{dM}{dt} = -(C_1 + C_2 * T + C_3 * V) * (M - M_e) \quad (3.9)$$

The above equation can be directly used in deep bed equations, provided that these equations are within the bounds of the experimentally determined coefficients. In addition, equation 3.9 assumes that resistance to moisture movement (gradients within the material) are negligible.

CHAPTER IV
RESULTS AND DISCUSSION

Drying Characteristics

The data collected during the study (Appendix A) includes: weight measurements recorded during drying, PDE codes, temperature and relative humidity readings of the surrounding air.

The reported weight measurements were used in equation 3.2 to determine the average initial dry-basis moisture content of each replication. Moisture content levels were also determined at each time interval for each replication. However, to determine the moisture ratios during the drying experiment, additional equilibrium moisture contents were required.

Whitelock (1997) conducted an equilibrium-moisture content study on Orange Lady marigolds at Oklahoma State University. This study was based on the saturated salt solution tests, which utilized a variety of salts to generate equilibrium moisture content data for the flowers, petals, and receptacles corresponding to relative humidity's of 11, 23, 33, 43, 52, 75, 86, and 97 percent. The results of Whitelock's experiment are located in Appendix B. These results were fitted to the Guggenheim-Anderson deBoer (GAB) equation, which is an equation for computing equilibrium moisture contents of agricultural materials. This equation is listed with four others including the Modified Henderson and Modified Chung-Pfost equations (1995 ASAS Standards). The GAB equation was fit to Whitelock's data because it fit the data better than the other equations.

The GAB equation is

$$MC = \frac{A * B * C * RH}{(1 - B * RH) * (1 - B * RH + B * C * RH)} \quad (4.1)$$

where MC is the dry-basis equilibrium moisture content, RH is percent relative humidity, A, B, and C are coefficients. This equation fit Whitelock's data for the flower, petals, and receptacle with r^2 values of 0.93, 0.93, and 0.79 respectively over a relative humidity range of five to seventy-five percent. Table III lists the coefficients for the GAB equation fit. Figure 3, Figure 4, and Figure 5 show the fitted curves and data of the flowers, petals, and receptacle respectively.

Table III: GAB coefficients for Whitelock's Orange Lady equilibrium moisture content data.

Description	A	B	C
Flower	0.065	0.99	1.7E19
Petal	0.064	1.09	4.5E21
Receptacle	0.11	0.71	11

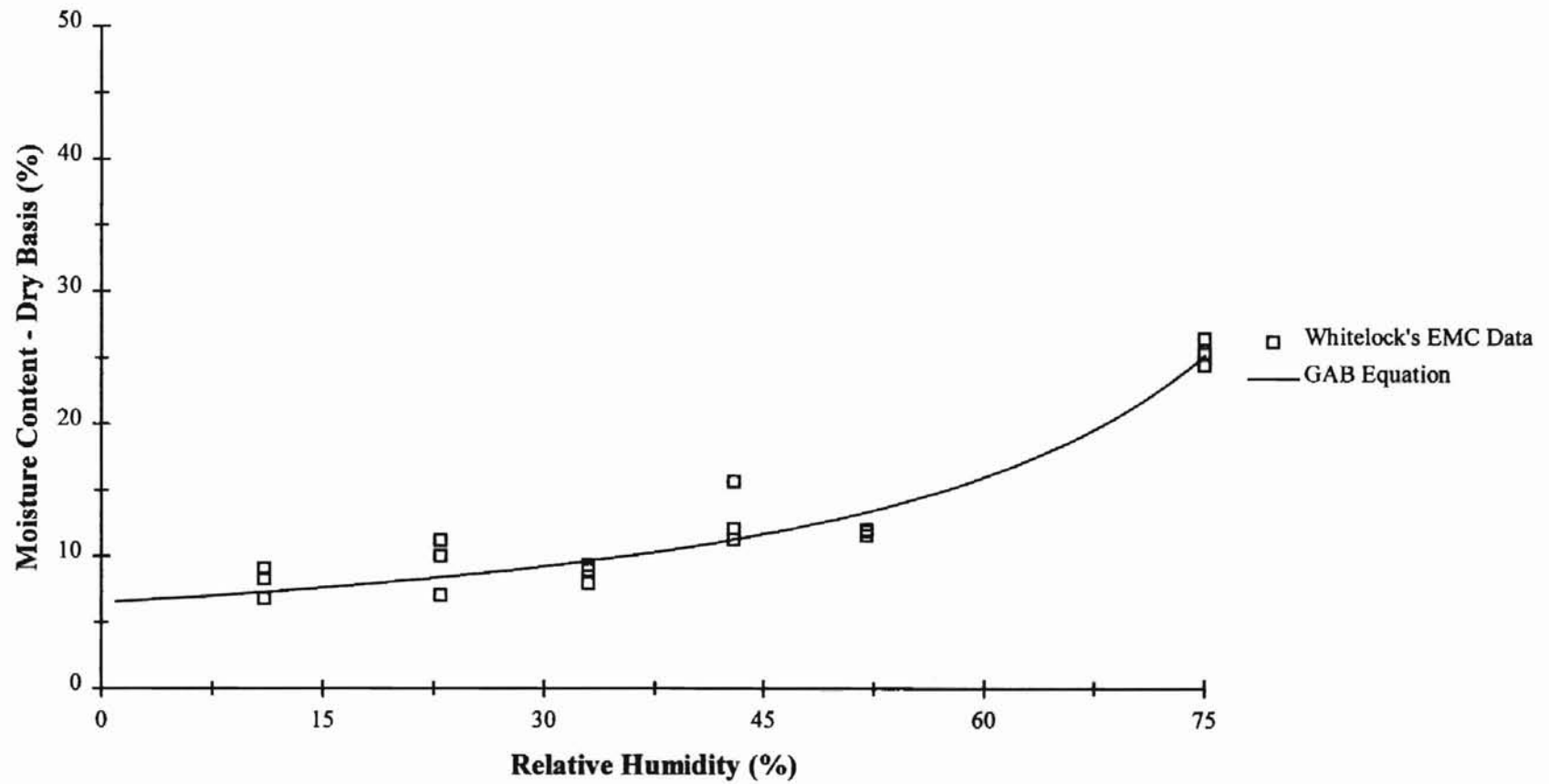


Figure 3: Flower equilibrium moisture content.

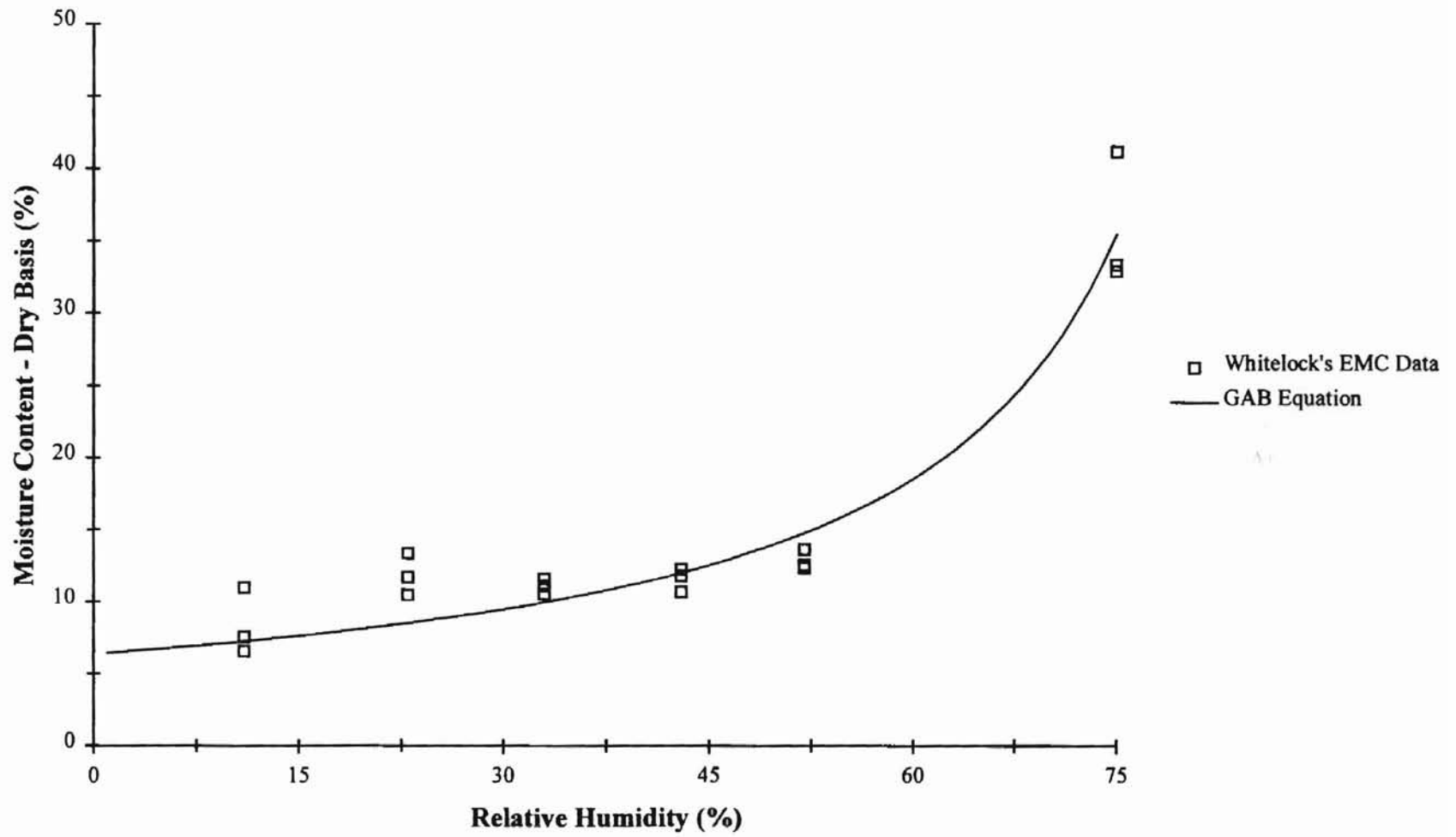


Figure 4: Petal equilibrium moisture content.

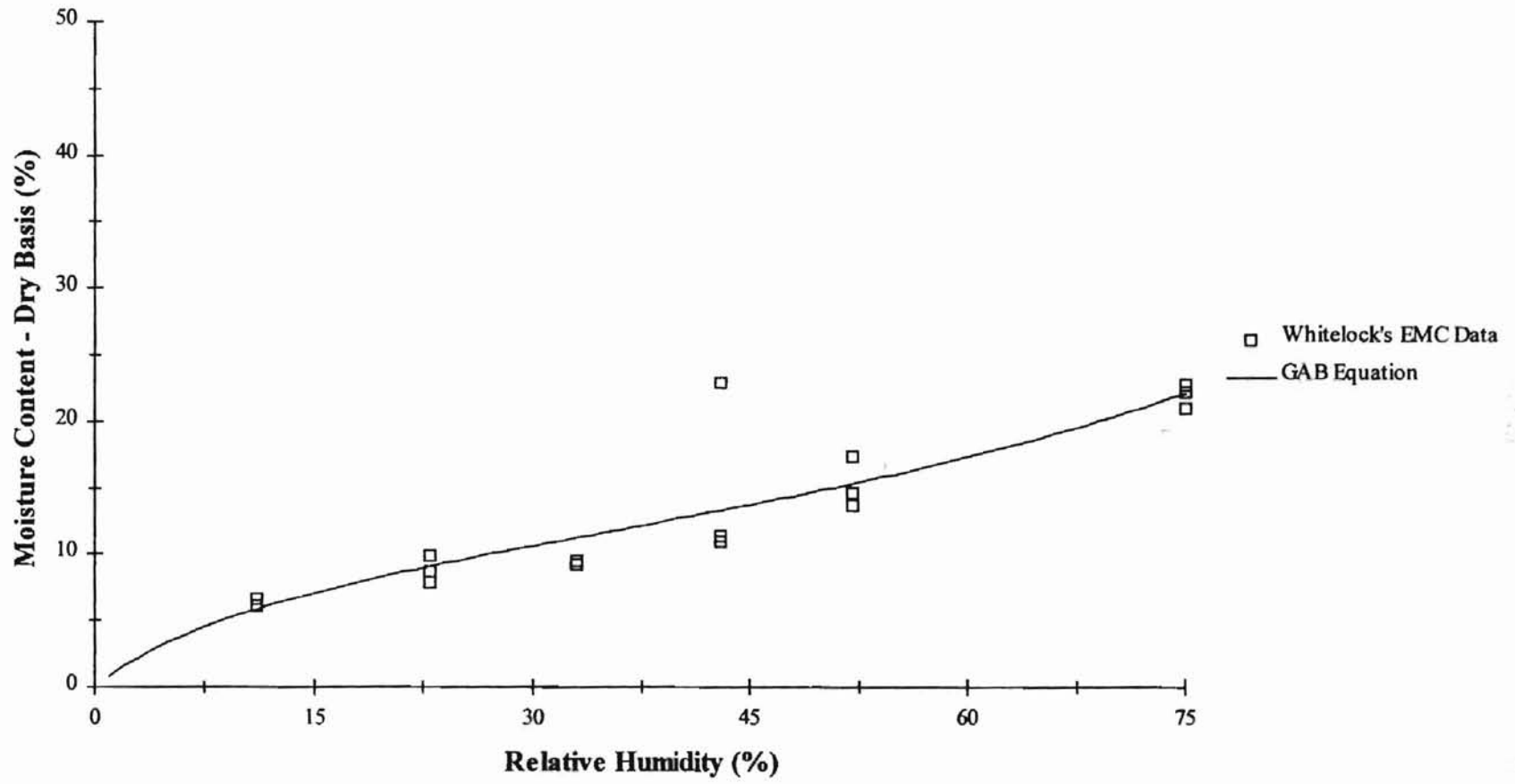


Figure 5: Receptacle equilibrium moisture content.

The data collected from the thin-layer drying experiment includes temperature and relative humidity readings from the Stillwater mesonet site (Elliott et al. 1994), which is 1 mile away from the Biosystems and Agricultural Engineering Laboratory. These readings correspond to the air conditions at the beginning of each drying run. These readings were determined as adequate representations of the dryer's inlet air conditions due to the low variation in absolute relative humidity throughout the drying cycles. In addition, the dryers were assumed to have zero air re-circulation. The relative humidity of the air after it passed over the heaters was computed using a Psychrometric chart.

The relative humidity of the air entering the drying bed and the results of the GAB equation fit of Whitelock's data were used to determine the equilibrium moisture content for each thin-layer drying test. These values and the moisture contents derived from equation 3.2 were used in equation 3.4 to determine the moisture ratio at each time interval for each test.

The drying rate coefficient for each replication of each test was determined by fitting the computed moisture ratios with the corresponding time interval to equation 3.3. Figures 6 and 7 show examples of the moisture content data and the fitted moisture content curves versus time for the whole flower, petals, and receptacle for an airflow rate of $0.28 \text{ m}^3/\text{sec m}^2$ and an air temperature of 60°C and 70°C , respectively. Table IV, Table V, and Table VI show the resulting drying coefficients (K) and their r^2 values for the flowers, petal, and receptacles respectively for all 12 combinations of air temperature and airflow rate.

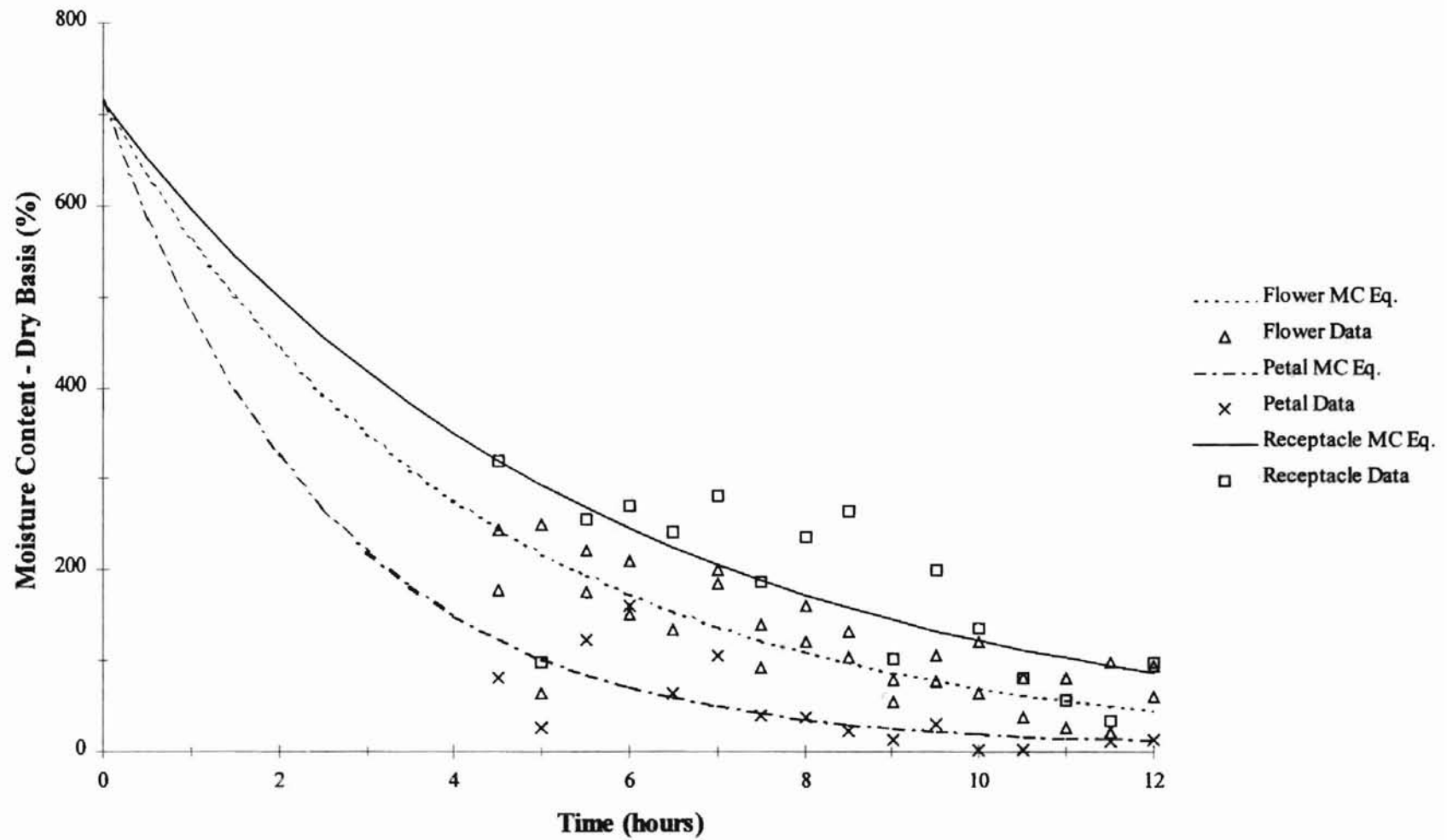


Figure 6: Moisture Content Curve-Fit at 60°C and 0.28 m³/sec m².

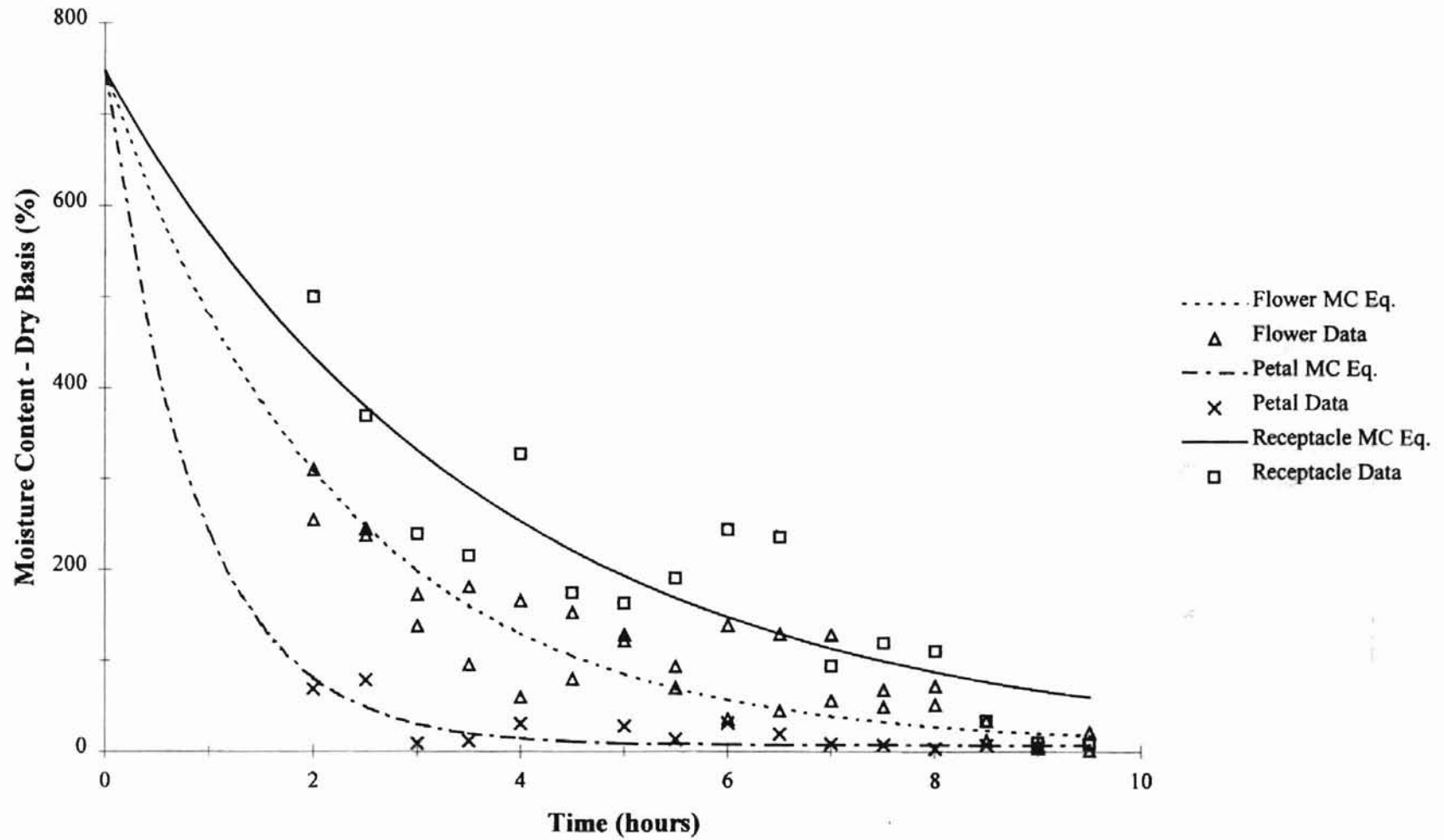


Figure 7: Moisture Content Curve-Fit at 70°C and 0.28 m³/sec m².

Table IV: Drying rate coefficients, K, and r^2 values for thin-layer whole flower data.
(3 replicates)

Airflow Rate	0.23 m ³ /sec m ²		0.28 m ³ /sec m ²		0.33 m ³ /sec m ²	
Temperature	K (hr ⁻¹)	r^2	K (hr ⁻¹)	r^2	K (hr ⁻¹)	r^2
55°C	0.15	0.91	0.21	0.90	0.17	0.88
	0.23	0.74	0.25	0.82	0.25	0.89
	0.14	0.91	0.18	0.85	0.17	0.79
60°C	0.25	0.95	0.24	0.88	0.24	0.84
	0.28	0.95	0.34	0.91	0.29	0.91
	0.22	0.92	0.20	0.86	0.23	0.79
65°C	0.28	0.87	0.34	0.81	0.34	0.93
	0.36	0.92	0.38	0.92	0.34	0.88
	0.25	0.90	0.28	0.81	0.26	0.84
70°C	0.34	0.91	0.45	0.91	0.44	0.88
	0.40	0.90	0.53	0.88	0.51	0.93
	0.32	0.83	0.44	0.89	0.41	0.85

Table V: Drying rate coefficients, K, and r^2 values for thin-layer petal data.
(3 replicates)

Airflow Rate	0.23 m ³ /sec m ²		0.28 m ³ /sec m ²		0.33 m ³ /sec m ²	
Temperature	K (hr ⁻¹)	r^2	K (hr ⁻¹)	r^2	K (hr ⁻¹)	r^2
55°C	0.16	0.98	0.26	0.87	0.26	0.96
	0.37	0.96	0.43	0.92	0.62	0.99
	0.14	0.94	0.20	0.91	0.23	0.86
60°C	0.36	0.97	0.40	0.95	0.47	0.98
	0.44	0.99	0.56	0.73	0.76	0.99
	0.29	0.95	0.32	0.92	0.54	0.96
65°C	0.43	0.87	1.04	0.98	0.38	0.89
	0.59	0.96	0.82	0.97	0.66	0.91
	0.61	0.95	0.52	0.86	0.41	0.90
70°C	0.55	0.91	1.15	0.99	0.77	0.94
	0.80	0.96	1.71	0.99	0.98	0.99
	0.47	0.84	0.79	0.99	0.76	0.98

Table VI: Drying rate coefficients, K, and r² values for thin-layer receptacle data.
(3 replicates)

Airflow Rate	0.23 m ³ /sec m ²		0.28 m ³ /sec m ²		0.33 m ³ /sec m ²	
Temperature	K (hr ⁻¹)	r ²	K (hr ⁻¹)	r ²	K (hr ⁻¹)	r ²
55°C	0.16	0.88	0.18	0.88	0.12	0.73
	0.17	0.81	0.22	0.83	0.20	0.81
	0.15	0.94	0.15	0.87	0.13	0.85
60°C	0.19	0.92	0.18	0.82	0.15	0.80
	0.19	0.90	0.25	0.87	0.19	0.84
	0.16	0.92	0.13	0.76	0.15	0.65
65°C	0.19	0.92	0.22	0.78	0.23	0.91
	0.22	0.88	0.24	0.85	0.24	0.79
	0.15	0.87	0.19	0.87	0.19	0.64
70°C	0.20	0.81	0.27	0.90	0.25	0.85
	0.28	0.91	0.31	0.84	0.29	0.84
	0.18	0.82	0.26	0.92	0.24	0.86

The drying rate coefficients determined from each test replication were used to derive equations for calculating drying rates based on a given air temperature and airflow rate entering the drying bed. These equations were determined by fitting the drying rate coefficients and their corresponding air temperatures and airflow rates to equation 3.5.

The resulting equations are

$$K = -0.65 + 0.013 * T + 0.35 * V \quad (4.2)$$

for the whole flower with an r² of 0.98,

$$K = -1.9 + 0.035 * T + 1.2 * V \quad (4.3)$$

for the petals with and r² of 0.88, and

$$K = -0.16 + 0.0053 * T + 0.095 * V \quad (4.4)$$

for the receptacle with and r² of 0.97, where T is air temperature in °C and V is airflow rate in m³/sec m². Figures 8 - 10 show the graphical representations of the flower, petal,

and receptacle equations respectively. Based on these graphs and equations 4.2, 4.3, and 4.4, it was determined that air temperature was more dominant than airflow rate in determining the drying coefficients.

These equations for determining drying coefficients were used in generating a few traditional thin-layer drying graphs. Figures 11 and 12 show the predicted moisture contents using equations 4.2, 4.3, and 4.4 in addition to the measured moisture contents versus time for an airflow rate of $0.28 \text{ m}^3/\text{sec m}^2$ and an air temperature of 60°C and 70°C , respectively. Based on this information, the moisture diffusion rates can be determined by equation 3.9. The coefficients C1, C2, and C3 are the coefficients represented in equation 4.2, 4.3, and 4.4 for the whole-flower, petals, and receptacle, respectively. Based on the constraints of the thin-layer experiment, the moisture diffusion rates should not be extrapolated outside the temperature range of 55°C to 70°C and the airflow rate range of 0.23 to $0.33 \text{ m}^3/\text{sec m}^2$.

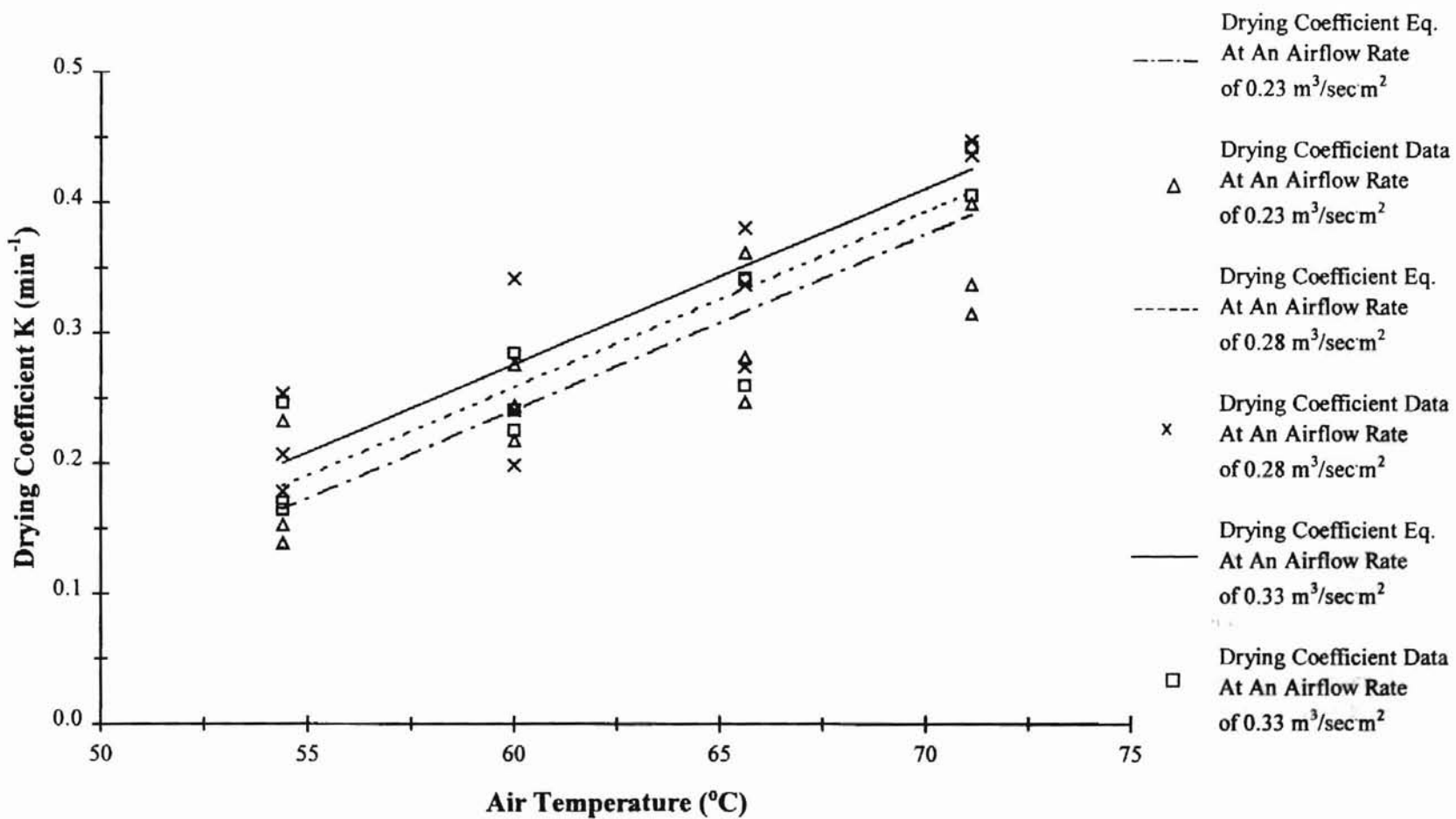


Figure 8: Flower drying coefficients.

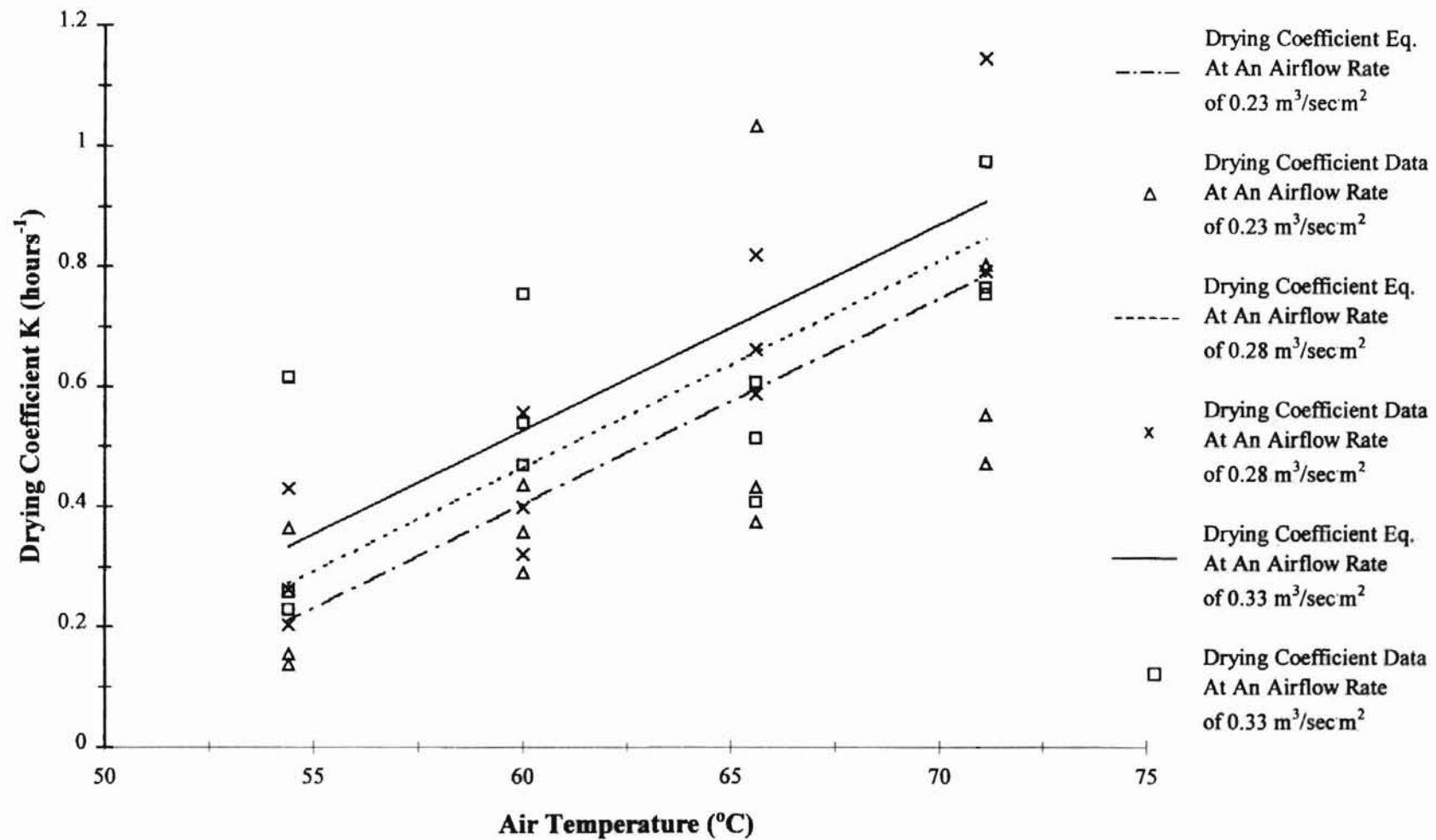


Figure 9: Petal drying coefficients.

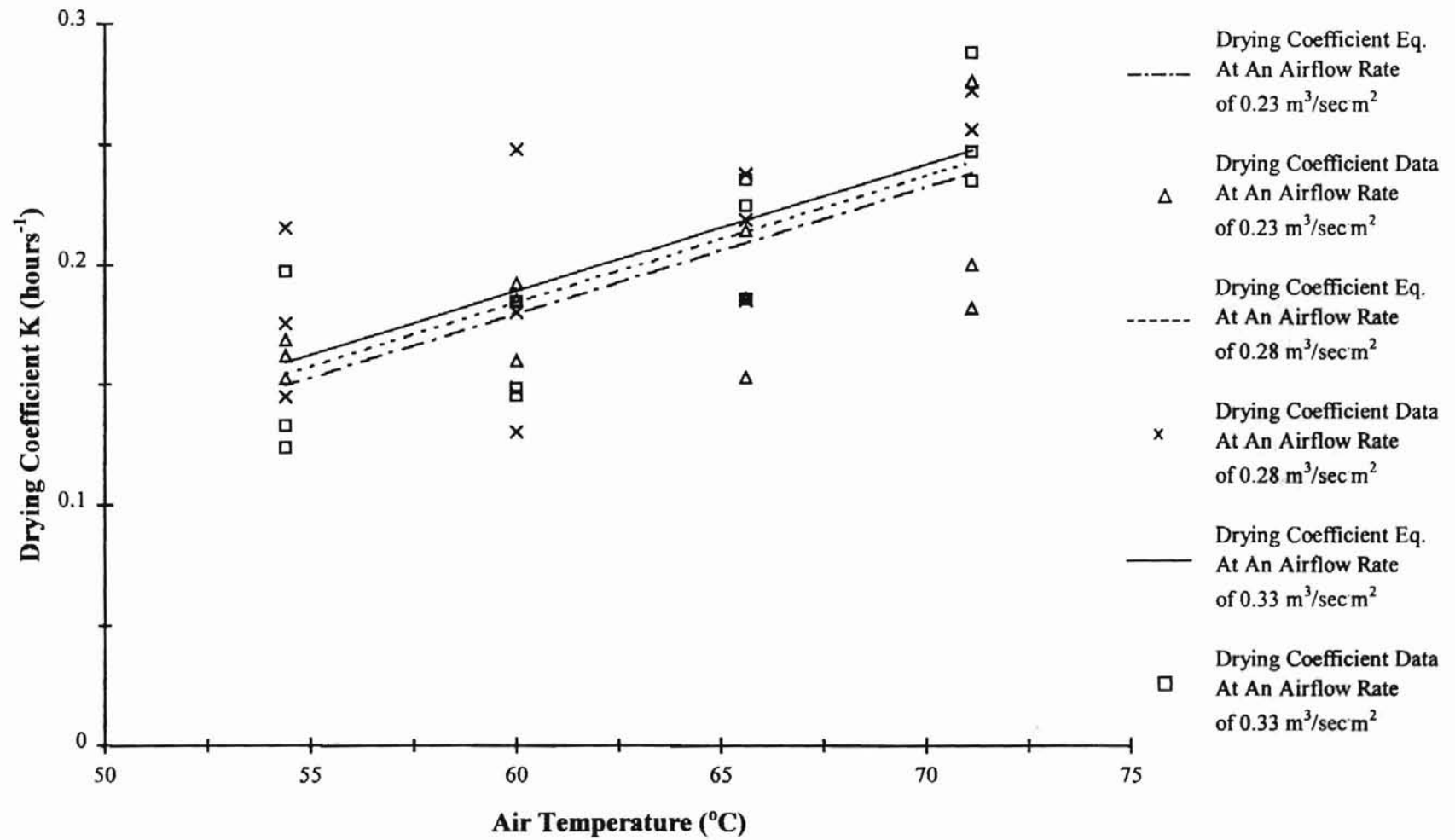


Figure 10: Receptacle drying coefficients.

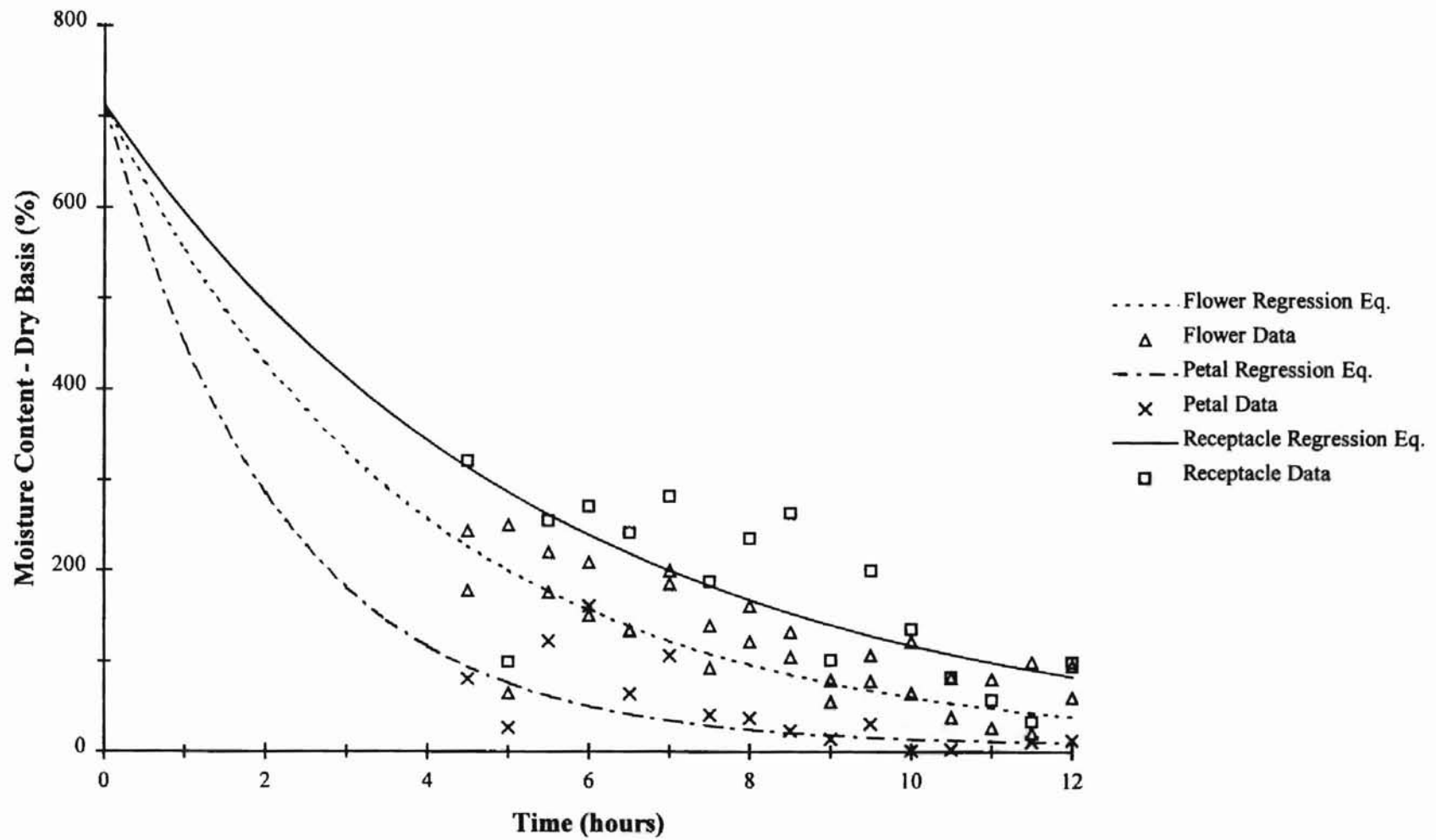


Figure 11: Moisture Content Profile Based on K Equations at 60°C and 0.28 m³/sec m².

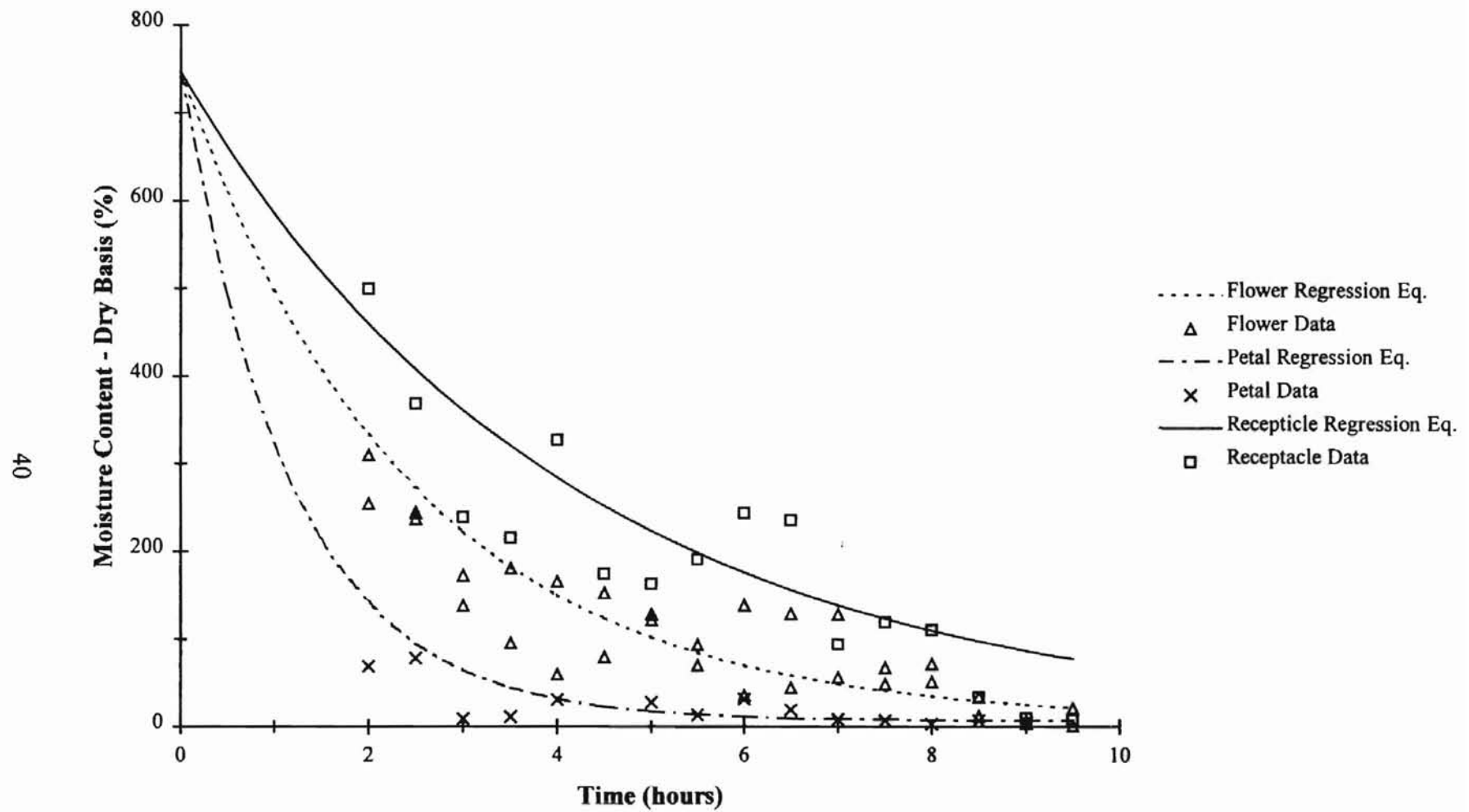


Figure 12: Moisture Content Profile Based on K Equations at 70°C and 0.28 m³/secm².

Petal Detachment

The petal detachment study was conducted on the flowers used in the xanthophyll study. The codes generated during the drying studies are located in Appendix A.

To represent the effects of air temperature and airflow rate on petal detachment, three graphs were generated (Figures 13-15) based on PDE codes at airflow rates of 0.23, 0.28 and 0.33 m³/sec m². Each graph was divided into four regions: under dried, over dried, optimum drying, and transition regions. The under dried region refers to an area on the graph where wet petals are expected and the over dried region refers to an area on the graph where dry petals and dry receptacles are expected for a given air temperature and drying time. The optimum drying region refers to an area on the graph where dry petals and wet receptacles are expected for a given air temperature and drying time. The transition region is divided into two regions, wet to dry petals and wet to dry receptacles. These two regions combined refer to an area on the graph where the petals and receptacle could be wet, damp, or dry. In addition to the drying regions, the PDE codes from the petal detachment study were overlaid on the graphs.

The profiles of the PDE codes (Figures 13-15) show that the optimum drying region increases with an increase in airflow rate. At an airflow rate of 0.23 m³/sec m², the graphs indicate that air temperatures in excess of 65°C are required for optimum petal detachment. At an airflow rate of 0.33 m³/sec m², air temperatures in excess of 60°C are required for optimum petal detachment. The graphs further indicate, air temperatures less than 60°C are not feasible for petal detachment. At air temperatures less than 60°C the petals and receptacles are drying at the same rate or the receptacles are drying faster than

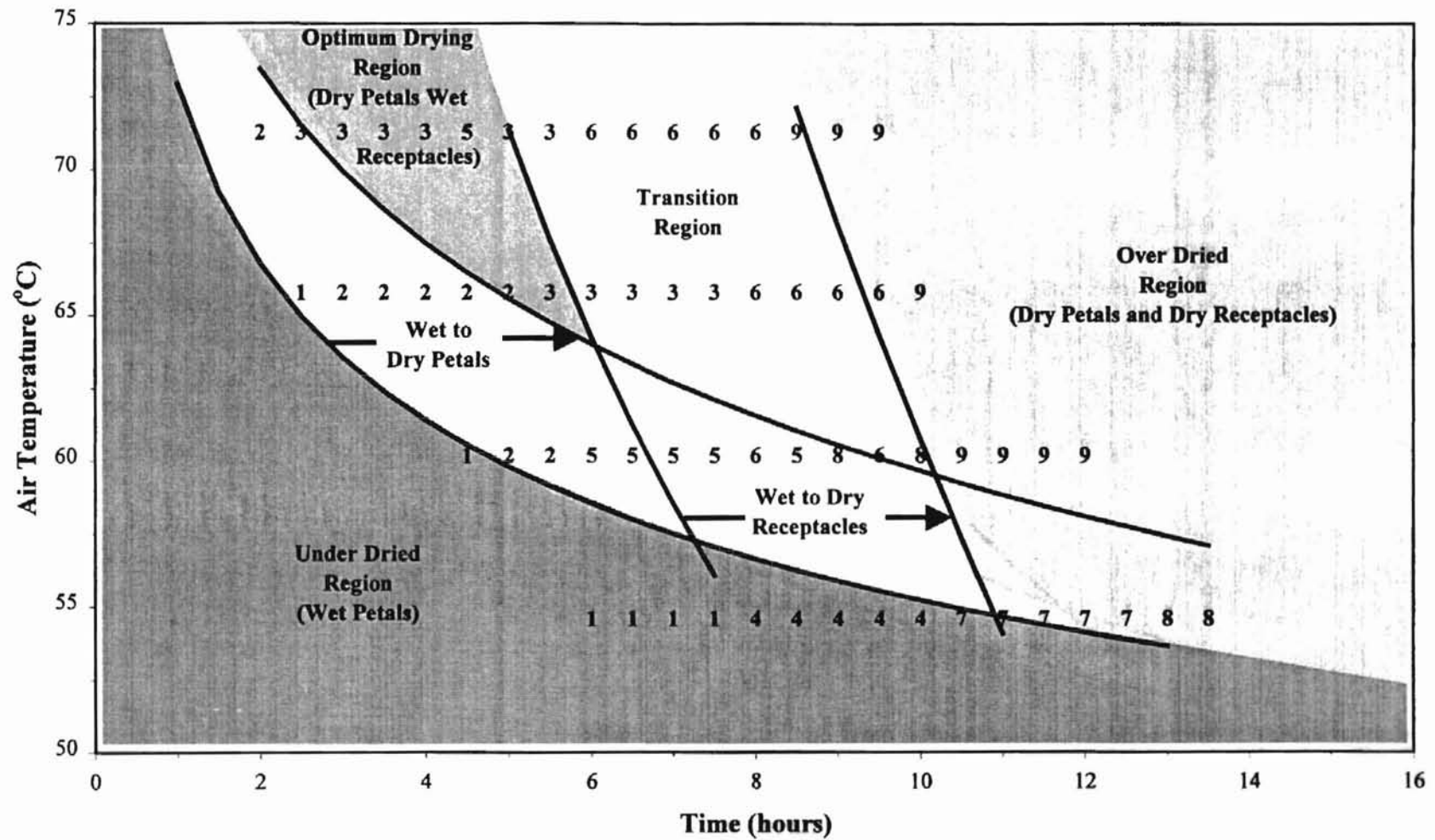


Figure 13: Profile of the PDE codes 1-9 (Table II) at an airflow rate of $0.23 \text{ m}^3/\text{sec m}^2$.

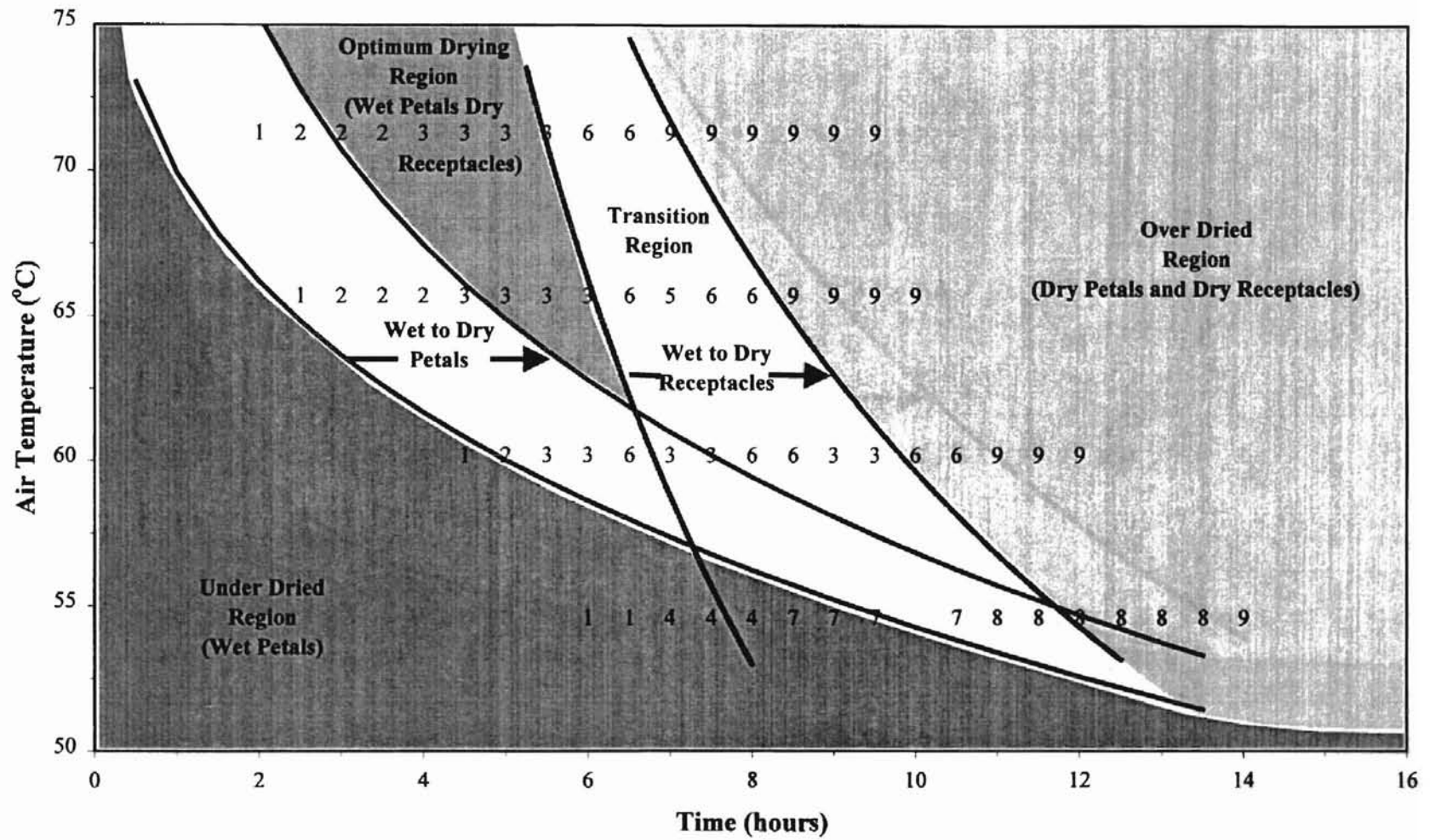


Figure 14: Profile of the PDE codes 1-9 (Table II) at an airflow rate of 0.28 m³/sec m².

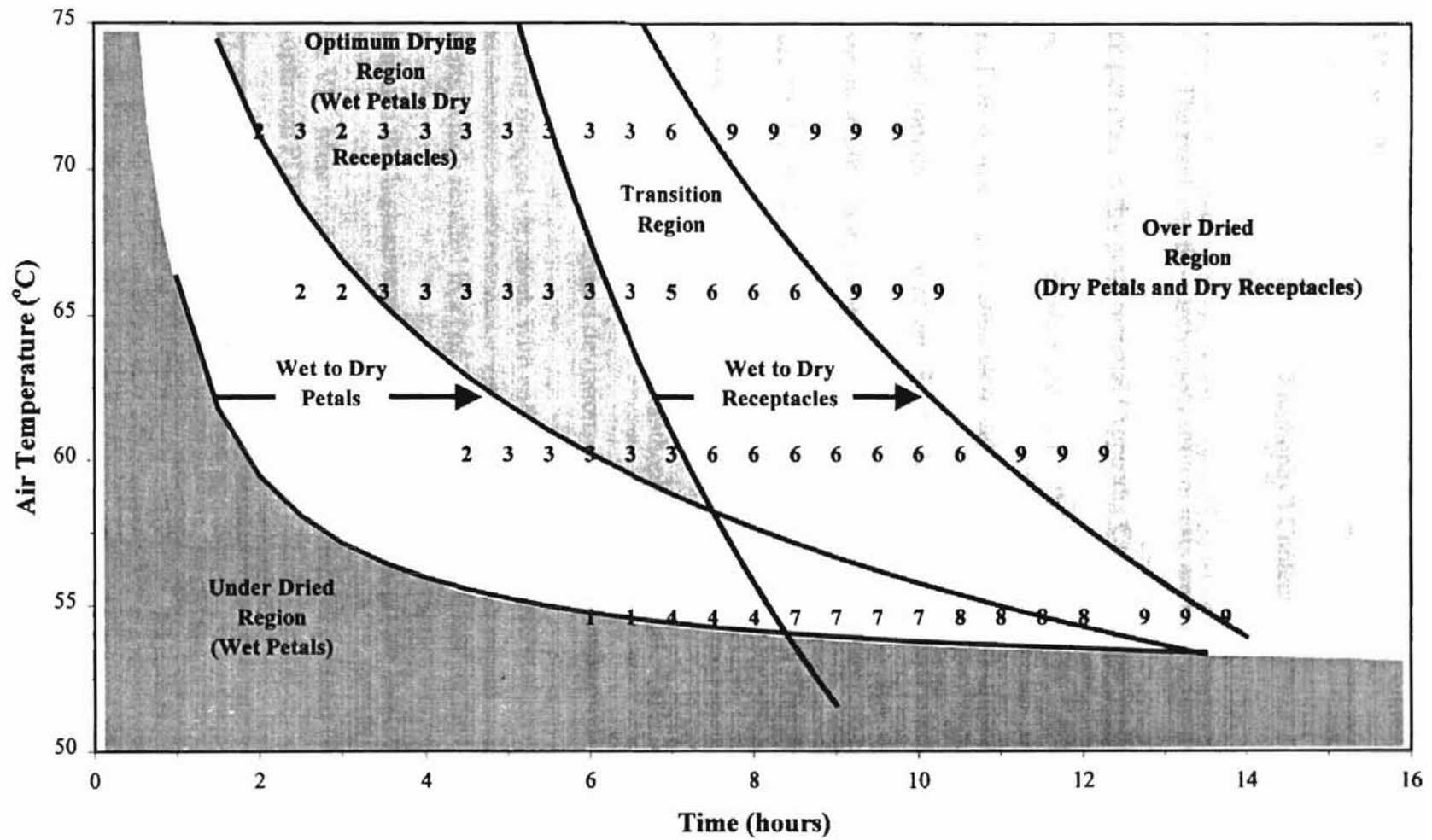


Figure 15: Profile of the PDE codes 1-9 (Table II) at an airflow rate of $0.33 \text{ m}^3/\text{secm}^2$.

the petals. Therefore, petal detachment was determined to be a function of both air temperature and airflow rate.

Xanthophyll Content

The results of the xanthophyll content tests are reported as average milligrams of lutein per gram of dry petal material (Appendix C). The xanthophyll contents of interest correspond to the drying times associated with the transition and optimum drying regions of the PDE profiles. The xanthophyll data in the time frames of these regions were selected from the whole data set. Figure 16 shows the selected xanthophyll contents versus air temperature. Based on the variability of the xanthophyll content data shown in Figure 16, the xanthophyll content after drying at various air temperatures and airflow rates was unable to be determined.

Due to the variability of the xanthophyll content data Table VII was generated to show the means and standard deviations of the selected xanthophyll contents. A t-test, assuming unequal variances, with an alpha 0.05 was performed on the xanthophyll contents, which resulted in a t of 2.4 and a t_{crit} of 1.7. Based on the t-test, it was determined that high air temperature during drying degrades xanthophyll content.

Table VII: Mean and standard deviation for xanthophyll contents (data associated with the optimum PDE region).

Air Temperature (°C)	Number of Samples	Mean	Standard Deviation
60	23	7.3	4.6
65	25	5.6	2.0
70	32	4.9	2.3

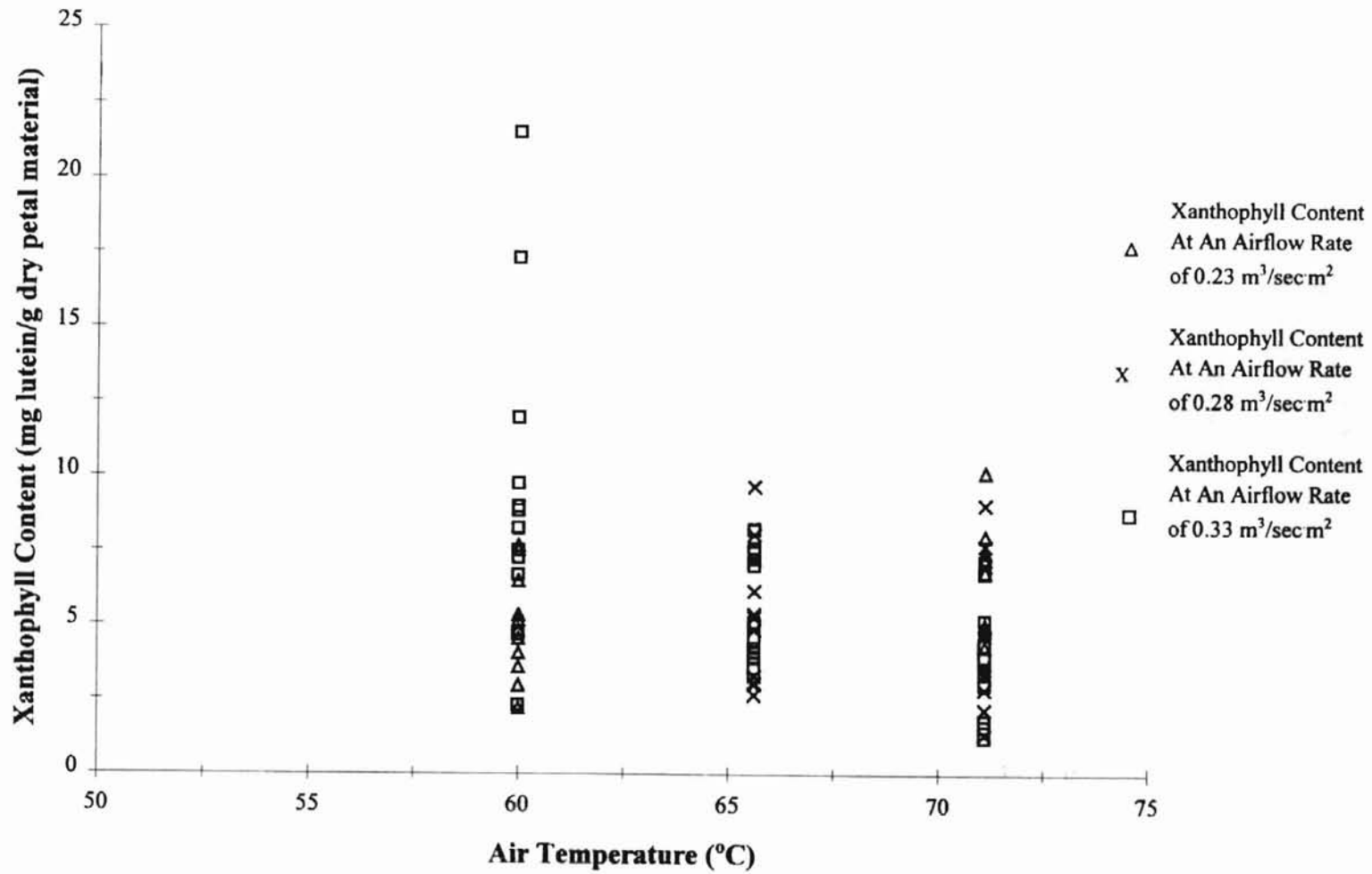


Figure 16: Xanthophyll content profile (Data associated with the optimum PDE region).

Drying Optimization

There are many factors involved in optimizing the drying process. They include: heater and blower initial costs, power cost, drying method, labor costs, xanthophyll reduction due to drying, temperature set-point, airflow set-point, and others. Each of these factors could greatly vary from one geographic location to the next. Therefore, this section focuses on the factors determined in this thin-layer drying study.

Assuming the drying facilities are capable of operating at a temperature range of 55 to 70°C and producing airflow rates of 0.23 to 0.33 m³/sec m², the optimization will encompass the bounds of the thin-layer study. Further, the initial and labor cost are assumed negligible while the drying process is assumed to be described by the thin-layer model. With these assumptions, the only unknown is the thin-layer model as a function of air temperature and airflow rate.

Based on the drying coefficient equations 4.2, 4.3, and 4.4, increasing the air temperature and airflow rate will increase the difference between the petal and receptacle moisture contents. This is more clearly shown in Figures 13 - 15. These graphs also show that the optimum drying region is greatly increased at the higher airflow rate and that temperatures less than 60°C are not feasible for petal detachment. From the drying coefficient equations and the PDE profiles, the ideal drying conditions would be an airflow rate of 0.33 m³/sec m² and an air temperature of 70°C. Increasing the drying temperature from 65 to 70°C reduces the drying time by approximately thirty minutes.

CHAPTER V

SUMMARY AND CONCLUSIONS

The moisture diffusion rate equations for the Orange Lady marigolds were derived from experimentally determined moisture contents through a thin-layer drying model. In the replications of all the tests, statistical differences were detected. These differences could relate to handling, uniformity of the air flow rate, or the variability of flower mass composition. To compensate for these differences, the drying coefficients of each replication were used to generate a linear model for the drying coefficients as a function of air temperature and airflow rate. These models for predicting drying coefficients produced r^2 values of 0.98, 0.88, and 0.97 for the flowers, petals, and receptacles respectively.

Based on the thin-layer drying experiment, it was concluded that the moisture diffusion rates for Orange Lady marigold flowers and flower components are distinctly different at high air temperatures and airflow rates. With these drying conditions, the petal components dried quicker than the whole flower, while the whole flower dried quicker than the receptacle components. As the air temperature decreased, the difference in moisture diffusion rates for the whole flower and flower components decreased. Further, the airflow rates were determined to be a minor factor in computing the moisture diffusion rates.

The thin-layer drying experiment produced oven dried weights for the petals and receptacles. From these measurements, it was determined the dried petal to dried receptacle mass ratio ranged between 1 and 2.

The identifying factors representing petal detachment were characterized qualitatively during the drying process. This was achieved by detaching the petals from the receptacle and describing each component as wet, damp, or dry. This experiment produced plots representing under-dried, over-dried, transition, and optimum drying regions.

Petal detachment was determined to be a function of air temperature and airflow rate. As air temperature and airflow rate increase, the optimum petal detachment region increased and the drying time required to attain optimum petal detachment decreased. At airflow rates of 0.23 and 0.33 m³/sec m², air temperatures in excess of 65 and 60°C were required for optimum petal detachment.

Xanthophyll was extracted from several samples, which were collected during the drying process, to determine xanthophyll content as a function of air temperature and airflow rate. There was a large variability in the xanthophyll content results. This variability could be associated with the variation of xanthophyll from flower to flower. It was concluded that single flower sampling during drying was not adequate for comparing xanthophyll reduction with air temperature and airflow rate. Statistical analysis showed that xanthophyll content degrades at high air temperatures during drying however, xanthophyll contents after drying were inconclusive due to the high xanthophyll content variability.

From the results of the drying experiment and the petal separation experiment, it was concluded that the optimum conditions in the range of 55 to 70°C and 0.23 to 0.33 m³/sec m² were an air temperature of 70°C and an airflow rate of 0.33 m³/sec m².

CHAPTER VI

RECOMMENDATIONS FOR FUTURE STUDY

The drying model in this experiment focused on Orange Lady marigolds. There are many different varieties of marigolds and one variety could produce a significant increase in yield for a given location. Therefore, it would be beneficial to perform additional thin-layer experiments on several different varieties. These experiments could demonstrate how variety effects the Orange Lady thin-layer model.

Further drying experiments should focus on the reduction of xanthophyll associated with drying conditions. This experiment should use larger sample sizes. A large sample size would solve part of the problems associated with the high variability of xanthophyll from flower to flower.

A bulk drying study could determine the most efficient means of commercial drying. This experiment should focus on dryer configurations to determine which configuration is more suitable for petal separation. The thin-layer model should be validated in an experimental study of dryer configuration. The experiments should consider the effects of air re-circulation on the drying process. Determining the re-circulation percentage would aid in creating an economic model.

Finally, an economic model should be developed to compare drying methods, separation methods, and drying conditions. This model would essentially combine all factors and determine the most economic means of processing marigolds for xanthophyll.

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APPENDIXES

Appendix A.1

Replication 1 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 34°C and 27% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying					PDE Code	
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
1	17.77	690	5.22	2.72	2.41	-	-	-	-	-	-	8
2	9.34	540	3.01	1.46	1.55	-	-	-	-	-	-	6
3	13.17	780	2.58	1.51	0.93	-	-	-	-	-	-	7
4	19.76	630	7.14	-	-	8.53	6.14	-	-	-	-	-
5	14.04	660	4.93	2.93	1.90	-	-	-	-	-	-	8
6	11.59	450	5.03	-	-	7.77	6.00	-	-	-	-	-
7	12.54	810	2.34	1.55	0.72	-	-	-	-	-	-	7
8	16.35	420	7.42	-	-	8.23	6.05	-	-	-	-	-
9	14.66	510	5.47	-	-	7.71	6.00	-	-	-	-	-
10	10.41	390	4.29	2.27	2.02	-	-	6.63	5.99	6.53	5.97	-
11	16.20	750	3.40	2.09	1.27	-	-	7.14	6.03	6.67	6.00	-
12	14.80	570	4.27	-	-	7.86	6.12	-	-	-	-	-
13	9.87	780	2.71	1.57	1.05	-	-	6.82	6.06	6.61	6.06	-
14	15.58	630	4.95	3.25	1.70	-	-	7.27	6.06	6.85	6.03	-
15	12.81	480	5.07	3.23	1.77	-	-	6.98	5.97	6.73	6.15	-
16	11.85	420	5.48	2.88	2.61	-	-	-	-	-	-	1
17	16.76	750	4.28	2.78	1.46	-	-	-	-	-	-	8
18	13.60	540	5.14	3.22	2.01	-	-	7.14	6.04	6.86	6.07	-
19	17.79	390	7.33	-	-	7.94	6.06	-	-	-	-	-
20	15.54	510	6.08	3.73	2.32	-	-	7.40	6.09	7.05	6.14	-
21	15.80	360	8.71	-	-	8.08	6.01	-	-	-	-	-
22	11.89	600	3.60	2.03	1.53	-	-	-	-	-	-	8
23	13.82	660	4.07	2.37	1.61	-	-	7.20	6.05	6.92	6.15	-
24	13.19	720	3.11	-	-	7.48	6.04	-	-	-	-	-

Appendix A.1 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	12.57	750	2.53	-	-	7.93	6.19	-	-	-	-	-
26	14.12	360	6.48	4.00	2.48	-	-	-	-	-	-	1
27	12.31	480	4.74	2.16	2.51	-	-	-	-	-	-	6
28	12.28	630	4.58	2.57	2.01	-	-	-	-	-	-	8
29	16.98	450	5.97	3.88	2.10	-	-	7.27	6.01	6.83	6.06	-
30	13.76	570	5.10	3.40	1.66	-	-	7.36	6.13	6.87	6.13	-
31	8.43	720	2.57	1.52	1.03	-	-	-	-	-	-	8
32	11.00	390	5.00	2.96	2.04	-	-	-	-	-	-	1
33	18.98	690	5.03	-	-	8.38	6.17	-	-	-	-	-
34	11.12	510	4.65	2.25	2.40	-	-	-	-	-	-	6
35	12.02	600	4.18	1.95	2.19	-	-	7.00	6.06	6.88	6.05	-
36	14.29	780	3.19	-	-	8.08	6.02	-	-	-	-	-
37	8.46	810	2.34	1.05	1.24	-	-	6.62	6.12	6.40	6.00	-
38	17.62	540	6.49	-	-	8.44	6.12	-	-	-	-	-
39	9.25	450	3.47	1.78	1.67	-	-	-	-	-	-	1
40	12.69	720	3.90	2.19	1.68	-	-	7.06	6.10	6.79	6.06	-
41	8.32	600	3.35	-	-	7.05	6.09	-	-	-	-	-
42	9.91	810	1.90	-	-	7.35	6.07	-	-	-	-	-
43	13.29	360	6.35	4.03	2.18	-	-	7.06	6.07	6.72	6.11	-
44	8.88	480	3.65	-	-	7.26	6.05	-	-	-	-	-
45	10.58	420	4.43	2.88	1.47	-	-	6.96	6.01	6.72	6.08	-
46	10.57	570	3.04	1.64	1.40	-	-	-	-	-	-	6
47	14.72	690	4.14	2.13	1.88	-	-	7.13	6.18	6.74	6.09	-
48	16.94	660	5.74	-	-	8.49	6.15	-	-	-	-	-

Appendix A.2

Replication 2 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 34°C and 27% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
49	12.73	750	2.96	0.99	1.97	-	-	6.90	5.98	7.10	6.09	-
50	13.51	780	2.55	0.84	1.58	-	-	7.02	6.08	7.17	6.16	-
51	13.02	660	2.46	-	-	7.76	6.09	-	-	-	-	-
52	12.17	540	3.03	-	-	7.84	5.96	-	-	-	-	-
53	22.23	600	4.29	-	-	8.47	6.06	-	-	-	-	-
54	12.42	420	3.67	1.56	2.11	-	-	7.10	6.10	6.84	6.09	-
55	12.00	390	3.58	1.89	1.67	-	-	-	-	-	-	1
56	15.43	510	4.67	1.99	2.67	-	-	7.25	6.13	7.12	6.11	-
57	12.99	480	3.44	1.15	2.28	-	-	-	-	-	-	6
58	10.58	720	2.07	0.61	1.44	-	-	-	-	-	-	8
59	10.68	630	2.15	0.58	1.55	-	-	-	-	-	-	8
60	12.19	360	3.89	-	-	7.72	6.05	-	-	-	-	-
61	11.29	750	1.69	-	-	7.35	6.00	-	-	-	-	-
62	12.18	600	1.91	0.92	0.96	-	-	6.92	6.06	6.73	6.00	-
63	15.46	630	2.54	-	-	7.87	6.10	-	-	-	-	-
64	12.60	690	2.45	1.01	1.36	-	-	7.08	6.00	7.12	6.14	-
65	8.92	390	2.85	0.96	1.87	-	-	6.75	6.09	6.60	6.13	-
66	10.31	480	2.23	-	-	7.31	6.09	-	-	-	-	-
67	10.68	720	1.70	-	-	7.46	6.04	-	-	-	-	-
68	12.59	510	2.87	-	-	7.79	6.21	-	-	-	-	-
69	13.50	360	4.43	1.47	2.93	-	-	-	-	-	-	1
70	10.27	810	1.87	0.51	1.26	-	-	-	-	-	-	7
71	12.81	450	3.96	1.03	2.92	-	-	6.87	6.08	6.99	6.07	-
72	15.45	570	3.13	1.10	2.01	-	-	-	-	-	-	6

Appendix A.2 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
73	10.96	540	2.02	0.85	1.08	-	-	6.97	6.04	6.86	6.06	-
74	11.02	750	1.67	0.81	0.91	-	-	-	-	-	-	8
75	14.08	570	2.34	-	-	7.84	6.12	-	-	-	-	-
76	11.71	510	3.08	0.93	2.13	-	-	-	-	-	-	6
77	13.80	390	4.72	-	-	7.92	5.99	-	-	-	-	-
78	12.31	420	3.54	-	-	7.33	6.05	-	-	-	-	-
79	19.44	450	5.63	-	-	8.34	6.14	-	-	-	-	-
80	12.55	780	3.21	0.90	2.29	-	-	-	-	-	-	8
81	12.48	630	2.34	1.18	1.10	-	-	7.06	5.99	6.89	6.11	-
82	10.90	810	1.92	-	-	7.52	5.95	-	-	-	-	-
83	12.25	690	3.02	0.84	2.09	-	-	-	-	-	-	8
84	13.96	660	3.10	1.01	2.06	-	-	-	-	-	-	8
85	12.37	690	2.64	-	-	6.64	6.09	-	-	-	-	-
86	14.65	720	3.06	0.97	2.04	-	-	6.96	6.00	7.01	6.13	-
87	12.42	480	3.67	0.86	2.72	-	-	6.88	6.05	7.06	6.08	-
88	12.44	600	2.21	0.85	1.24	-	-	-	-	-	-	6
89	14.86	450	5.50	1.50	3.99	-	-	-	-	-	-	1
90	12.40	570	3.94	1.07	2.86	-	-	6.94	6.07	6.82	6.09	-
91	11.78	420	3.89	1.60	2.24	-	-	-	-	-	-	1
92	14.43	660	3.96	0.86	3.10	-	-	6.90	6.05	6.97	5.96	-
93	14.32	360	7.50	3.07	4.40	-	-	7.08	6.02	6.93	5.99	-
94	9.92	810	1.54	0.77	0.77	-	-	6.85	6.05	6.82	6.17	6
95	16.55	540	5.67	2.54	3.11	-	-	-	-	-	-	-
96	14.15	780	2.16	-	-	8.03	6.02	-	-	-	-	-

Appendix A.3

Replication 3 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 34°C and 27% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
97	15.15	750	4.21	2.18	2.07	-	-	-	-	-	-	8
98	13.58	390	6.45	3.63	2.78	-	-	7.06	6.09	6.86	6.08	-
99	11.05	780	3.03	1.75	1.26	-	-	7.01	6.06	6.70	6.08	-
100	13.37	690	4.07	2.60	1.47	-	-	-	-	-	-	8
101	18.90	570	6.90	4.25	2.59	-	-	7.48	6.13	7.05	6.08	-
102	9.31	450	3.46	1.96	1.50	-	-	6.71	6.18	6.60	6.13	-
103	9.68	360	5.38	-	-	7.42	6.16	-	-	-	-	-
104	12.38	630	4.21	2.51	1.75	-	-	-	-	-	-	8
105	12.09	480	5.69	3.22	2.45	-	-	-	-	-	-	1
106	11.23	510	4.38	2.17	2.15	-	-	-	-	-	-	6
107	13.28	600	5.66	3.33	2.25	-	-	7.06	6.03	6.93	6.11	-
108	10.47	720	3.13	1.85	1.18	-	-	-	-	-	-	8
109	10.48	750	2.86	-	-	7.55	6.07	-	-	-	-	-
110	16.32	420	8.31	-	-	8.34	5.98	-	-	-	-	-
111	13.99	780	4.08	2.67	1.34	-	-	-	-	-	-	7
112	14.10	720	3.87	2.17	1.72	-	-	7.05	6.10	6.89	6.20	-
113	16.55	540	7.19	4.51	2.60	-	-	7.34	5.99	7.03	6.06	-
114	13.92	390	7.50	-	-	7.90	6.04	-	-	-	-	-
115	17.36	600	6.03	-	-	8.20	6.09	-	-	-	-	-
116	11.57	480	4.86	-	-	7.66	6.10	-	-	-	-	-
117	13.89	360	6.40	3.61	2.71	-	-	6.92	6.09	6.61	6.02	-
118	11.23	630	3.38	2.11	1.23	-	-	6.99	6.12	6.67	6.05	-
119	11.39	660	3.23	-	-	7.52	6.03	-	-	-	-	-
120	11.19	510	4.58	2.55	1.99	-	-	6.91	6.02	6.90	6.07	-

Appendix A.3 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
121	9.09	810	2.69	1.57	1.12	-	-	-	-	-	-	7
122	16.69	570	5.93	-	-	8.09	5.99	-	-	-	-	-
123	12.81	660	3.60	2.31	1.29	-	-	7.04	6.10	6.72	6.10	-
124	9.15	450	4.09	-	-	7.40	6.05	-	-	-	-	-
125	16.50	630	6.78	-	-	8.38	6.05	-	-	-	-	-
126	14.08	690	4.37	-	-	7.84	6.07	-	-	-	-	-
127	11.87	750	3.01	1.91	1.09	-	-	6.98	6.07	6.76	6.22	-
128	12.94	390	6.63	4.36	2.25	-	-	-	-	-	-	1
129	12.64	540	6.06	3.25	2.73	-	-	-	-	-	-	6
130	14.64	780	4.03	-	-	8.01	6.13	-	-	-	-	-
131	8.70	420	4.50	2.63	1.84	-	-	-	-	-	-	1
132	17.76	510	7.75	-	-	8.47	6.00	-	-	-	-	-
133	11.48	810	2.18	1.24	0.92	-	-	6.90	6.02	6.78	6.18	-
134	12.34	600	4.08	2.38	1.70	-	-	-	-	-	-	6
135	14.67	420	6.92	4.04	2.87	-	-	7.21	6.06	6.91	6.05	-
136	15.15	690	5.52	3.42	1.99	-	-	7.27	6.02	6.92	6.05	-
137	10.85	360	6.55	3.65	2.90	-	-	-	-	-	-	1
138	11.93	480	4.50	2.84	1.62	-	-	7.19	6.12	6.67	5.98	-
139	11.99	570	5.11	3.09	1.95	-	-	-	-	-	-	6
140	15.01	660	4.81	2.87	2.04	-	-	-	-	-	-	8
141	8.19	450	3.60	2.29	1.35	-	-	-	-	-	-	1
142	13.29	810	3.30	-	-	7.95	6.11	-	-	-	-	-
143	11.34	540	5.13	-	-	7.71	6.13	-	-	-	-	-
144	12.05	720	4.79	-	-	7.60	6.08	-	-	-	-	-

Appendix A.4

Replication 1 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 75% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
1	17.67	780	2.50	-	-	8.21	5.96	-	-	-	-	-
2	18.18	720	2.90	-	-	7.94	6.02	-	-	-	-	-
3	7.30	480	1.33	0.39	0.77	-	-	-	-	-	-	6
4	16.04	510	3.07	1.77	1.23	-	-	7.29	6.09	6.86	6.17	-
5	12.68	450	3.61	-	-	7.56	6.01	-	-	-	-	-
6	8.26	720	2.15	0.80	1.31	-	-	-	-	-	-	7
7	9.45	840	1.99	0.62	1.43	-	-	-	-	-	-	7
8	12.27	630	2.92	1.66	1.25	-	-	-	-	-	-	8
9	12.13	660	3.10	1.31	1.73	-	-	-	-	-	-	8
10	16.56	750	2.88	1.65	1.17	-	-	7.35	6.04	6.80	6.01	-
11	6.70	360	2.84	1.23	1.60	-	-	-	-	-	-	1
12	24.93	570	7.36	4.71	2.58	-	-	7.75	6.03	7.06	6.09	-
13	21.66	630	3.66	1.63	2.00	-	-	7.46	6.06	7.04	6.00	-
14	8.50	780	1.78	0.34	1.44	-	-	-	-	-	-	7
15	10.24	390	3.24	0.81	2.49	-	-	6.68	6.15	6.87	6.08	-
16	8.60	420	3.82	0.68	3.13	-	-	6.54	6.07	6.83	5.99	-
17	13.16	510	2.23	-	-	7.50	6.09	-	-	-	-	-
18	7.95	540	2.27	0.60	1.69	-	-	6.53	6.09	6.50	6.02	-
19	5.79	690	1.77	0.21	1.35	-	-	6.33	6.04	6.48	6.07	-
20	17.69	660	3.41	1.92	1.38	-	-	7.35	6.04	6.84	6.05	-
21	17.11	810	2.47	-	-	7.91	5.98	-	-	-	-	-
22	12.84	360	5.45	-	-	7.56	6.13	-	-	-	-	-
23	13.90	480	3.72	-	-	7.63	6.08	-	-	-	-	-
24	14.60	750	2.90	-	-	7.82	6.01	-	-	-	-	-

Appendix A.4 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	12.98	810	2.47	1.42	1.01	-	-	-	-	-	-	7
26	13.94	450	5.23	3.26	1.95	-	-	6.93	6.02	6.51	5.92	-
27	17.28	390	7.15	-	-	8.14	6.02	-	-	-	-	-
28	10.72	750	1.34	0.75	0.57	-	-	-	-	-	-	7
29	16.51	480	5.19	2.40	2.78	-	-	7.25	6.09	7.15	6.02	-
30	12.51	540	2.80	-	-	7.41	5.99	-	-	-	-	-
31	14.24	720	2.63	1.67	0.96	-	-	7.16	6.05	6.71	6.04	-
32	10.12	420	4.20	2.09	2.06	-	-	-	-	-	-	6
33	12.19	630	2.41	-	-	7.45	5.95	-	-	-	-	-
34	8.48	570	2.78	0.79	1.94	-	-	-	-	-	-	8
35	9.59	840	2.51	0.63	1.82	-	-	6.62	6.05	6.88	6.09	-
36	16.00	690	2.90	1.79	1.13	-	-	-	-	-	-	7
37	25.05	810	5.13	3.56	1.51	-	-	7.95	6.01	6.93	6.11	-
38	9.32	660	2.65	-	-	7.42	6.04	-	-	-	-	-
39	14.91	450	3.69	2.02	1.61	-	-	-	-	-	-	6
40	8.76	540	2.11	0.22	1.60	-	-	-	-	-	-	8
41	8.18	570	2.03	-	-	6.96	6.05	-	-	-	-	-
42	6.35	390	2.35	0.78	1.54	-	-	-	-	-	-	1
43	19.27	360	7.66	4.69	2.97	-	-	7.50	6.05	6.88	5.98	-
44	21.37	420	8.55	-	-	8.77	6.12	-	-	-	-	-
45	14.57	780	1.89	0.89	0.96	-	-	6.98	6.05	6.68	6.08	8
46	12.95	510	3.47	1.73	1.72	-	-	-	-	-	-	-
47	22.17	840	4.25	-	-	8.90	6.17	-	-	-	-	-
48	15.05	690	2.40	-	-	7.67	6.08	-	-	-	-	-

Appendix A.5

Replication 2 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 75% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
49	9.72	810	1.69	0.55	0.95	-	-	6.71	6.08	6.76	6.12	-
50	10.36	570	1.84	0.52	1.09	-	-	6.78	6.08	6.78	6.08	-
51	19.52	660	3.45	-	-	8.28	6.13	-	-	-	-	-
52	15.04	450	2.86	1.16	1.62	-	-	-	-	-	-	6
53	17.97	540	3.45	1.23	2.11	-	-	7.17	5.98	6.88	6.01	-
54	8.79	840	1.33	0.52	0.77	-	-	6.50	5.98	6.71	6.01	-
55	10.09	750	1.31	0.46	0.78	-	-	6.62	6.09	6.86	6.15	-
56	17.70	480	2.69	1.17	1.48	-	-	-	-	-	-	8
57	16.27	390	3.44	1.27	2.17	-	-	-	-	-	-	1
58	8.10	690	1.05	0.57	0.45	-	-	-	-	-	-	7
59	11.31	360	2.58	1.03	1.54	-	-	-	-	-	-	1
60	9.67	630	1.07	0.57	0.51	-	-	-	-	-	-	7
61	12.40	570	2.41	-	-	7.77	6.04	-	-	-	-	-
62	8.17	750	1.24	-	-	7.02	6.06	-	-	-	-	-
63	11.21	420	3.72	2.17	1.50	-	-	-	-	-	-	6
64	9.35	780	1.38	0.62	0.78	-	-	-	-	-	-	7
65	12.68	510	2.91	1.15	1.77	-	-	-	-	-	-	8
66	12.35	810	2.51	-	-	7.48	6.05	-	-	-	-	-
67	10.56	450	3.70	1.11	2.45	-	-	6.65	6.03	6.64	5.94	-
68	11.50	720	2.00	-	-	7.89	6.12	-	-	-	-	-
69	9.57	390	1.63	0.74	0.86	-	-	6.73	6.01	6.73	6.13	-
70	15.29	360	2.80	1.07	1.69	-	-	7.09	6.10	6.73	6.06	-
71	12.30	480	1.99	0.72	1.18	-	-	6.87	6.15	6.82	6.09	-
72	15.85	630	2.00	-	-	7.66	6.03	-	-	-	-	-

Appendix A.5 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code	
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)		
73	10.04	540	2.92	-	-	7.27	6.03	-	-	-	-	-	-
74	8.89	420	4.34	1.95	2.28	-	-	6.71	6.06	6.56	6.00	-	-
75	9.35	570	2.05	0.70	1.29	-	-	-	-	-	-	8	-
76	13.84	660	1.98	1.05	0.87	-	-	-	-	-	-	7	-
77	9.46	810	1.57	0.64	0.83	-	-	-	-	-	-	9	-
78	12.37	780	3.74	1.66	1.89	-	-	7.07	6.00	6.86	6.12	-	-
79	16.58	360	7.05	-	-	8.15	6.09	-	-	-	-	-	-
80	9.57	840	1.71	-	-	7.25	6.06	-	-	-	-	-	-
81	19.30	510	7.72	-	-	8.53	6.10	-	-	-	-	-	-
82	8.89	720	1.77	0.60	1.08	-	-	-	-	-	-	7	-
83	15.01	690	2.37	1.09	1.32	-	-	7.07	6.01	7.05	6.05	-	-
84	17.18	450	4.45	-	-	8.02	6.00	-	-	-	-	-	-
85	10.64	720	1.80	0.71	1.09	-	-	6.80	6.06	6.65	5.96	-	-
86	10.37	690	2.24	-	-	7.48	6.07	-	-	-	-	-	-
87	12.65	660	2.02	0.73	1.24	-	-	6.80	6.07	7.01	6.18	-	-
88	18.15	510	4.36	1.48	2.88	-	-	7.43	6.15	7.22	6.08	-	-
89	9.81	750	1.43	0.64	0.78	-	-	-	-	-	-	7	-
90	12.11	390	3.48	-	-	7.67	6.12	-	-	-	-	-	-
91	14.11	630	2.43	0.92	1.44	-	-	6.93	6.00	6.87	5.99	-	-
92	8.53	540	2.17	0.31	1.68	-	-	-	-	-	-	8	-
93	10.31	840	1.35	0.56	0.74	-	-	-	-	-	-	9	-
94	19.28	480	3.95	-	-	8.47	6.13	-	-	-	-	-	-
95	12.87	420	3.49	-	-	7.78	6.06	-	-	-	-	-	-
96	7.89	780	0.83	-	-	6.82	6.02	-	-	-	-	-	-

Appendix A.6

Replication 3 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 75% respectively.

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
97	8.09	840	1.30	-	-	7.14	6.09	-	-	-	-	-
98	7.97	360	2.47	0.60	1.90	-	-	-	-	-	-	1
99	6.97	480	1.75	0.49	1.26	-	-	6.43	6.06	6.57	6.18	-
100	17.05	570	3.11	-	-	8.16	6.11	-	-	-	-	-
101	16.07	450	4.24	-	-	8.08	5.99	-	-	-	-	-
102	8.44	390	3.51	1.12	2.35	-	-	-	-	-	-	1
103	11.58	660	2.70	1.23	1.36	-	-	-	-	-	-	7
104	18.12	720	4.56	-	-	7.91	5.99	-	-	-	-	-
105	12.22	510	4.28	-	-	7.35	6.11	-	-	-	-	-
106	11.52	630	4.31	2.53	1.82	-	-	-	-	-	-	8
107	17.52	780	4.05	-	-	8.18	6.08	-	-	-	-	-
108	14.05	750	3.23	1.50	1.72	-	-	-	-	-	-	7
109	15.59	690	2.31	-	-	7.87	6.06	-	-	-	-	-
110	13.93	450	4.35	2.55	1.79	-	-	7.25	6.16	6.79	6.03	-
111	12.77	810	2.29	1.26	0.98	-	-	-	-	-	-	7
112	15.12	360	5.15	-	-	8.06	6.12	-	-	-	-	-
113	14.78	750	3.59	1.68	1.85	-	-	7.08	6.13	6.77	6.16	-
114	15.46	630	4.78	2.88	1.90	-	-	7.04	5.98	6.63	5.91	-
115	8.86	840	1.61	0.55	1.03	-	-	6.63	6.10	6.73	6.06	-
116	11.45	420	3.69	2.13	1.58	-	-	-	-	-	-	1
117	11.61	570	4.01	1.70	2.26	-	-	7.04	6.15	6.93	6.17	-
118	9.00	480	3.40	-	-	7.26	6.13	-	-	-	-	-
119	7.84	720	2.88	0.83	2.07	-	-	-	-	-	-	7
120	15.73	540	4.36	-	-	7.72	6.02	-	-	-	-	-

Appendix A.6 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
121	15.63	690	2.74	1.82	0.92	-	-	-	-	-	-	7
122	11.82	450	4.24	2.40	1.82	-	-	-	-	-	-	6
123	9.41	540	2.70	1.26	1.43	-	-	-	-	-	-	8
124	12.52	720	3.47	1.43	1.88	-	-	7.08	6.13	6.76	6.04	-
125	8.09	840	1.53	0.45	1.03	-	-	-	-	-	-	9
126	15.77	510	4.11	2.25	1.88	-	-	7.28	6.07	6.89	6.06	-
127	12.46	390	5.62	-	-	7.78	6.15	-	-	-	-	-
128	15.53	780	3.02	1.90	1.19	-	-	-	-	-	-	7
129	20.19	420	7.46	-	-	8.37	6.06	-	-	-	-	-
130	22.66	810	4.34	2.80	1.57	-	-	7.93	6.06	7.16	6.07	-
131	8.94	570	2.11	0.53	1.60	-	-	-	-	-	-	8
132	13.81	660	4.31	2.37	1.91	-	-	7.04	6.02	6.69	6.01	-
133	9.81	810	3.37	-	-	7.54	6.16	-	-	-	-	-
134	11.15	480	4.68	2.59	2.03	-	-	-	-	-	-	6
135	6.84	540	2.50	1.13	1.35	-	-	6.59	6.05	6.51	6.08	-
136	20.35	690	4.85	3.21	1.52	-	-	7.76	6.07	6.98	6.11	-
137	9.21	630	2.60	-	-	7.25	6.01	-	-	-	-	-
138	10.57	420	4.89	2.61	2.26	-	-	6.80	6.08	6.67	6.05	-
139	18.58	750	4.27	-	-	8.47	6.13	-	-	-	-	-
140	9.15	360	4.71	1.89	2.80	-	-	6.48	5.97	6.61	6.03	-
141	8.19	510	2.01	0.42	1.55	-	-	-	-	-	-	8
142	8.62	390	4.16	1.49	2.65	-	-	6.68	6.13	6.72	6.08	-
143	17.87	660	3.81	-	-	8.28	6.08	-	-	-	-	-
144	11.96	780	2.97	1.23	1.74	-	-	6.77	5.92	6.68	6.07	-

Appendix A.7

Replication 1 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 26°C and 69% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
1	27.72	600	6.49	2.94	3.57	-	-	7.76	6.00	7.43	6.09	-
2	19.16	810	2.44	-	-	8.18	6.13	-	-	-	-	-
3	16.92	750	3.90	1.57	2.25	-	-	7.01	5.96	6.87	5.98	-
4	24.34	720	5.74	-	-	8.85	6.06	-	-	-	-	-
5	18.04	360	7.88	-	-	7.99	6.00	-	-	-	-	-
6	18.65	660	4.23	-	-	8.23	6.14	-	-	-	-	-
7	19.11	480	6.15	-	-	8.20	6.09	-	-	-	-	-
8	12.77	390	4.98	2.09	2.86	-	-	6.98	6.11	6.86	6.21	-
9	12.56	420	5.38	-	-	7.53	6.11	-	-	-	-	-
10	10.92	540	3.77	0.76	2.98	-	-	6.80	6.15	6.88	6.18	-
11	18.78	510	4.50	1.70	2.70	-	-	-	-	-	-	6
12	11.78	690	3.10	1.02	2.06	-	-	6.86	6.19	6.47	6.06	-
13	16.95	630	5.68	-	-	8.05	6.10	-	-	-	-	-
14	10.43	780	2.82	0.60	2.15	-	-	6.68	6.14	6.81	6.03	-
15	10.15	600	3.61	0.71	2.89	-	-	-	-	-	-	8
16	14.93	510	5.28	-	-	7.97	6.01	-	-	-	-	-
17	11.71	750	3.90	-	-	7.57	6.12	-	-	-	-	-
18	11.89	360	5.27	2.03	3.21	-	-	-	-	-	-	1
19	9.95	630	3.32	0.71	2.62	-	-	-	-	-	-	7
20	10.16	720	3.03	0.49	2.39	-	-	6.49	5.95	6.66	5.95	-
21	15.62	450	5.13	1.39	3.65	-	-	-	-	-	-	6
22	11.11	480	4.66	1.13	3.51	-	-	6.89	6.27	6.80	6.05	-
23	20.06	570	4.78	-	-	8.34	6.10	-	-	-	-	-
24	13.92	690	3.95	-	-	7.66	6.08	-	-	-	-	-

Appendix A.7 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	10.07	780	2.70	0.50	2.25	-	-	-	-	-	-	9
26	16.12	750	3.68	1.58	2.10	-	-	-	-	-	-	9
27	22.38	360	7.99	5.00	2.99	-	-	7.66	6.12	6.88	6.04	-
28	8.00	510	3.45	0.62	2.64	-	-	6.48	6.04	6.72	6.02	-
29	13.87	810	2.56	1.46	1.11	-	-	7.23	6.15	6.74	6.11	-
30	13.76	660	3.17	1.74	1.48	-	-	7.08	6.17	6.79	6.05	-
31	10.65	390	4.28	1.18	3.12	-	-	-	-	-	-	1
32	10.41	420	4.22	1.48	2.68	-	-	6.70	6.12	6.93	6.13	-
33	12.39	450	4.08	-	-	7.69	6.12	-	-	-	-	-
34	17.33	570	2.58	2.55	2.98	-	-	7.18	6.08	6.94	6.06	-
35	10.27	630	2.33	0.57	1.81	-	-	6.61	6.08	6.87	6.12	-
36	11.33	540	2.35	1.03	1.22	-	-	-	-	-	-	8
37	15.84	570	3.44	1.42	1.94	-	-	-	-	-	-	8
38	12.87	540	4.12	-	-	7.61	6.11	-	-	-	-	-
39	10.00	810	2.27	0.93	1.29	-	-	-	-	-	-	9
40	11.69	480	2.96	1.49	1.47	-	-	-	-	-	-	6
41	12.75	420	4.47	1.09	3.36	-	-	-	-	-	-	1
42	9.60	780	2.07	-	-	7.24	6.06	-	-	-	-	-
43	9.43	390	4.98	-	-	7.30	6.06	-	-	-	-	-
44	14.87	660	3.59	1.68	1.88	-	-	-	-	-	-	7
45	10.62	450	4.58	1.20	3.27	-	-	6.65	6.10	6.85	6.02	-
46	9.85	690	2.76	1.15	1.59	-	-	-	-	-	-	7
47	9.44	720	3.63	0.61	3.00	-	-	-	-	-	-	7
48	15.90	600	5.50	-	-	7.86	5.98	-	-	-	-	-

Appendix A.8

Replication 2 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.33 m³/secm². The air temperature and relative humidity corresponding to the dryer inlet conditions were 26°C and 69% respectively.

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
49	17.98	600	2.34	1.07	1.25	-	-	7.01	6.01	6.91	6.18	-
50	10.82	780	1.62	0.61	1.00	-	-	-	-	-	-	9
51	19.48	540	2.43	1.27	1.05	-	-	-	-	-	-	8
52	15.23	480	4.99	-	-	8.00	6.01	-	-	-	-	-
53	17.18	750	3.25	-	-	8.23	6.03	-	-	-	-	-
54	15.97	360	5.38	1.45	3.88	-	-	7.10	6.06	7.00	6.07	-
55	12.14	510	4.32	0.61	3.68	-	-	-	-	-	-	8
56	8.48	660	1.34	0.48	0.85	-	-	-	-	-	-	7
57	5.58	630	0.75	0.31	0.36	-	-	-	-	-	-	7
58	4.64	390	0.99	0.34	0.64	-	-	-	-	-	-	6
59	14.64	720	1.78	1.00	0.72	-	-	-	-	-	-	9
60	14.65	420	2.92	0.85	2.13	-	-	6.91	6.10	6.99	6.12	-
61	10.05	750	2.43	0.35	1.92	-	-	-	-	-	-	9
62	11.42	480	4.81	0.75	4.04	-	-	6.72	6.06	6.92	6.00	-
63	14.73	510	4.55	-	-	7.70	5.99	-	-	-	-	-
64	11.35	720	2.77	-	-	7.60	6.12	-	-	-	-	-
65	9.05	810	1.71	0.35	1.26	-	-	-	-	-	-	9
66	17.75	690	4.28	1.32	2.88	-	-	-	-	-	-	7
67	9.81	600	2.81	0.47	2.30	-	-	-	-	-	-	7
68	12.55	390	4.29	0.87	3.39	-	-	6.70	6.02	6.99	6.03	-
69	10.50	360	5.62	1.04	4.55	-	-	-	-	-	-	1
70	8.82	450	1.81	0.52	1.13	-	-	-	-	-	-	6
71	14.38	570	4.38	0.93	3.41	-	-	6.96	6.05	7.24	6.08	-
72	23.79	630	3.61	1.46	2.11	-	-	7.43	6.02	7.36	5.94	-

Appendix A.8 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
73	11.87	510	1.17	0.66	0.46	-	-	6.70	6.02	6.55	6.03	-
74	16.30	660	2.35	0.97	1.34	-	-	7.05	6.09	7.23	6.11	-
75	9.41	780	1.36	0.35	0.89	-	-	6.61	6.13	6.87	6.11	-
76	4.93	420	0.50	0.26	0.21	-	-	-	-	-	-	6
77	17.80	630	2.27	-	-	7.87	5.95	-	-	-	-	-
78	8.33	390	2.10	-	-	7.06	6.04	-	-	-	-	-
79	8.46	810	0.84	0.52	0.31	-	-	6.61	6.07	6.28	5.94	-
80	16.67	570	3.24	-	-	8.16	6.07	-	-	-	-	-
81	20.88	540	4.65	-	-	8.37	5.99	-	-	-	-	-
82	19.41	450	4.54	-	-	8.32	6.06	-	-	-	-	-
83	9.06	750	1.56	0.46	1.03	-	-	6.46	6.06	6.80	6.06	-
84	14.64	690	2.45	0.83	1.51	-	-	6.94	6.09	6.83	5.96	-
85	13.31	720	2.30	0.72	1.56	-	-	6.79	6.04	6.89	6.02	-
86	15.24	690	2.65	-	-	7.81	6.09	-	-	-	-	-
87	11.58	570	2.10	0.76	1.37	-	-	-	-	-	-	8
88	10.65	540	1.83	0.77	1.04	-	-	6.86	6.10	6.80	6.03	-
89	19.34	600	3.54	-	-	8.28	6.12	-	-	-	-	-
90	18.02	360	7.53	-	-	8.13	6.02	-	-	-	-	-
91	15.28	480	3.79	0.93	2.87	-	-	-	-	-	-	8
92	7.67	780	0.83	-	-	6.94	6.12	-	-	-	-	-
93	9.34	810	1.14	-	-	7.14	6.01	-	-	-	-	-
94	13.36	420	5.05	-	-	7.81	6.07	-	-	-	-	-
95	9.70	450	3.51	0.50	3.01	-	-	6.44	6.00	6.89	6.07	-
96	13.12	660	2.28	-	-	7.60	6.16	-	-	-	-	-

Appendix A.9

Replication 3 data for thin-layer drying at an air temperature of 55°C and an airflow of 0.33 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 26°C and 69% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
97	13.42	600	3.11	1.46	1.64	-	-	-	-	-	-	8
98	19.91	660	4.08	1.87	2.20	-	-	7.29	6.06	6.94	6.02	-
99	14.55	390	5.11	2.80	2.33	-	-	7.19	6.12	6.87	6.11	-
100	5.05	450	1.25	-	-	6.62	6.02	-	-	-	-	-
101	9.51	510	3.71	1.02	2.62	-	-	-	-	-	-	8
102	17.16	480	5.79	3.01	2.76	-	-	-	-	-	-	6
103	11.29	780	3.62	-	-	7.44	6.09	-	-	-	-	-
104	11.98	630	4.32	-	-	7.71	5.99	-	-	-	-	-
105	11.45	360	5.02	2.04	2.89	-	-	6.71	6.06	6.58	6.07	-
106	18.29	720	3.21	1.54	1.65	-	-	7.24	6.08	6.98	6.12	-
107	11.73	570	3.39	1.03	2.36	-	-	-	-	-	-	8
108	10.15	810	2.46	-	-	7.30	6.02	-	-	-	-	-
109	11.08	810	1.71	0.67	0.93	-	-	6.68	6.01	6.79	6.10	-
110	24.19	720	5.38	2.82	2.54	-	-	-	-	-	-	7
111	10.41	630	3.88	0.87	3.01	-	-	-	-	-	-	7
112	18.55	510	5.65	2.67	2.95	-	-	7.40	6.08	6.95	6.12	-
113	12.80	420	4.77	0.80	3.95	-	-	6.74	6.06	7.10	6.08	-
114	20.01	390	8.79	-	-	8.27	6.10	-	-	-	-	-
115	12.81	480	4.94	-	-	7.50	6.03	-	-	-	-	-
116	13.21	540	2.33	-	-	7.75	6.08	-	-	-	-	-
117	11.47	360	4.90	2.30	2.59	-	-	-	-	-	-	1
118	16.82	750	3.58	-	-	7.95	6.02	-	-	-	-	-
119	13.30	690	3.89	-	-	7.75	6.03	-	-	-	-	-
120	13.06	600	2.87	0.77	2.10	-	-	6.71	6.03	7.03	6.19	-

Appendix A.9 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
121	14.81	510	3.34	-	-	7.96	6.03	-	-	-	-	-
122	12.42	720	3.10	-	-	7.58	6.06	-	-	-	-	-
123	11.01	450	3.36	0.99	2.19	-	-	-	-	-	-	6
124	24.44	630	6.91	3.86	3.01	-	-	7.83	5.97	7.17	6.06	-
125	20.71	660	6.49	-	-	8.97	6.23	-	-	-	-	-
126	8.82	780	2.14	0.43	1.61	-	-	6.62	6.16	6.73	6.10	-
127	8.36	420	3.17	0.80	2.23	-	-	-	-	-	-	6
128	9.05	540	3.65	1.00	2.60	-	-	-	-	-	-	8
129	16.05	750	4.40	2.64	1.68	-	-	7.25	6.08	6.92	6.11	-
130	10.40	360	5.99	-	-	7.43	6.04	-	-	-	-	-
131	9.95	570	4.56	1.77	2.83	-	-	6.76	6.09	6.83	6.12	-
132	14.01	390	6.30	2.82	3.44	-	-	-	-	-	-	1
133	15.73	600	3.68	-	-	7.92	6.08	-	-	-	-	-
134	12.27	450	4.83	1.28	3.38	-	-	6.68	6.04	7.08	6.13	-
135	10.81	660	2.28	0.81	1.41	-	-	-	-	-	-	7
136	11.77	780	1.83	0.82	0.93	-	-	-	-	-	-	9
137	10.26	480	4.50	1.40	3.02	-	-	6.69	6.06	6.81	6.10	-
138	10.36	810	2.10	0.97	1.16	-	-	-	-	-	-	9
139	7.87	690	2.44	0.78	1.66	-	-	-	-	-	-	7
140	17.27	750	3.21	1.49	1.62	-	-	-	-	-	-	7
141	16.00	540	5.87	3.28	2.55	-	-	7.25	6.06	6.91	6.11	-
142	16.12	690	5.34	3.29	2.09	-	-	7.33	6.14	6.87	6.11	-
143	10.84	420	6.84	-	-	7.51	6.05	-	-	-	-	-
144	13.92	570	5.04	-	-	7.72	6.09	-	-	-	-	-

Appendix A.10

Replication 1 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 21°C and 82% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	Tare (grams)
1	11.35	420	2.63	0.92	1.68	-	-	-	-	-	-	5
2	13.63	720	2.57	-	-	7.61	6.06	-	-	-	-	-
3	10.50	510	2.07	0.78	1.29	-	-	-	-	-	-	7
4	12.39	600	2.42	1.06	1.35	-	-	-	-	-	-	9
5	12.06	390	4.11	2.21	1.87	-	-	-	-	-	-	5
6	12.03	660	2.54	1.19	1.32	-	-	-	-	-	-	9
7	11.48	300	4.44	1.71	2.68	-	-	-	-	-	-	2
8	17.76	480	3.87	1.96	1.91	-	-	-	-	-	-	7
9	12.98	270	5.67	1.99	3.60	-	-	6.93	6.09	6.89	6.07	-
10	13.94	360	4.65	-	-	7.74	6.05	-	-	-	-	-
11	12.00	540	2.30	0.78	1.51	-	-	6.81	6.06	6.88	6.05	-
12	15.69	630	3.14	-	-	8.03	5.97	-	-	-	-	-
13	9.66	510	1.62	-	-	7.38	6.09	-	-	-	-	-
14	12.89	450	3.46	1.39	2.10	-	-	6.92	5.99	6.65	5.92	-
15	15.50	330	5.43	2.62	2.79	-	-	7.22	6.08	6.97	6.09	-
16	14.10	690	2.95	1.61	1.30	-	-	-	-	-	-	9
17	14.54	420	3.54	1.57	1.95	-	-	7.09	6.03	6.87	6.21	-
18	12.26	300	4.84	2.36	2.44	-	-	6.97	6.14	6.73	6.05	-
19	14.13	660	2.95	1.31	1.63	-	-	6.94	5.92	6.84	5.97	-
20	12.04	540	2.27	0.92	1.32	-	-	-	-	-	-	7
21	12.61	630	2.57	1.06	1.41	-	-	7.01	6.06	6.86	6.05	-
22	14.57	270	6.13	-	-	7.92	6.03	-	-	-	-	-
23	15.17	390	3.93	1.23	2.55	-	-	6.92	6.04	6.81	6.07	-
24	15.73	570	3.40	-	-	7.89	6.16	-	-	-	-	-

Appendix A.10 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
25	12.77	540	2.60	-	-	7.71	6.07	-	-	-	-	-
26	17.73	450	3.71	-	-	8.27	5.97	-	-	-	-	-
27	12.11	690	2.39	-	-	7.38	6.05	-	-	-	-	-
28	10.89	660	1.84	-	-	7.46	6.01	-	-	-	-	-
29	14.94	300	6.78	-	-	7.81	5.93	-	-	-	-	-
30	13.02	600	2.86	-	-	7.86	6.16	-	-	-	-	-
31	9.59	360	3.25	1.43	1.82	-	-	-	-	-	-	5
32	13.46	420	4.19	-	-	7.73	6.15	-	-	-	-	-
33	11.83	570	2.62	0.59	2.02	-	-	6.63	6.04	6.81	6.20	-
34	9.71	720	2.01	0.69	1.27	-	-	6.60	6.06	6.76	6.01	-
35	14.03	330	5.81	1.83	3.93	-	-	-	-	-	-	2
36	13.81	480	3.64	0.71	2.93	-	-	6.84	6.10	6.91	6.08	-
37	13.39	330	4.75	-	-	7.69	6.10	-	-	-	-	-
38	16.52	600	3.71	1.87	1.82	-	-	7.25	6.05	6.92	6.06	-
39	12.54	720	2.62	0.80	1.79	-	-	-	-	-	-	9
40	15.76	510	3.70	1.86	1.80	-	-	7.30	6.13	6.95	6.18	-
41	12.40	570	2.42	1.01	1.41	-	-	-	-	-	-	9
42	15.87	390	5.54	-	-	8.10	6.21	-	-	-	-	-
43	14.97	480	4.94	-	-	8.05	6.16	-	-	-	-	-
44	13.76	450	3.94	1.47	2.47	-	-	-	-	-	-	7
45	11.98	360	4.03	1.70	2.31	-	-	6.99	6.13	6.79	6.05	-
46	12.05	630	2.65	0.66	1.89	-	-	-	-	-	-	9
47	11.48	270	5.35	2.16	3.16	-	-	-	-	-	-	1
48	10.96	690	1.80	0.76	1.04	-	-	6.76	6.06	6.79	6.05	-

Appendix A.11

Replication 2 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 21°C and 82% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
49	13.41	690	1.89	-	-	7.74	6.12	-	-	-	-	-
50	11.07	720	1.82	-	-	7.47	6.15	-	-	-	-	-
51	12.03	600	1.95	0.63	1.15	-	-	-	-	-	-	9
52	10.50	630	1.67	0.71	0.96	-	-	6.82	6.10	6.70	5.91	-
53	13.69	480	3.60	1.07	2.53	-	-	-	-	-	-	4
54	14.72	270	5.49	2.09	3.26	-	-	7.01	5.98	7.10	6.13	-
55	11.85	360	3.14	0.90	2.28	-	-	-	-	-	-	2
56	10.78	510	3.02	0.58	2.34	-	-	-	-	-	-	4
57	18.07	390	6.39	3.12	3.25	-	-	7.55	6.03	7.06	6.18	-
58	13.06	570	2.26	0.75	1.51	-	-	6.77	6.02	6.86	6.14	-
59	20.99	450	4.61	-	-	8.56	6.01	-	-	-	-	-
60	13.03	330	4.47	-	-	7.65	6.07	-	-	-	-	-
61	13.40	390	3.08	0.97	2.07	-	-	-	-	-	-	5
62	10.64	660	1.65	-	-	7.28	6.13	-	-	-	-	-
63	17.49	480	3.30	-	-	8.03	6.10	-	-	-	-	-
64	13.45	540	2.11	-	-	7.65	6.12	-	-	-	-	-
65	12.39	300	3.53	0.77	2.75	-	-	-	-	-	-	2
66	13.50	510	3.03	0.89	2.14	-	-	6.89	6.11	6.76	6.02	-
67	11.18	720	1.88	0.65	1.21	-	-	6.70	6.08	6.66	6.04	-
68	13.53	630	2.84	-	-	7.81	6.07	-	-	-	-	-
69	14.18	270	5.91	-	-	7.58	5.96	-	-	-	-	-
70	16.93	600	3.66	1.27	2.36	-	-	7.13	6.10	7.01	6.10	-
71	18.60	420	3.79	-	-	8.35	6.05	-	-	-	-	-
72	15.10	360	4.97	1.26	3.70	-	-	6.95	6.04	7.03	6.10	-

Appendix A.11 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	11.76	660	1.99	0.74	1.22	-	-	-	-	-	-	9
74	14.32	270	4.84	1.18	3.45	-	-	-	-	-	-	1
75	14.81	510	2.61	-	-	7.89	6.13	-	-	-	-	-
76	13.85	690	1.93	1.04	0.89	-	-	-	-	-	-	9
77	19.11	300	5.87	-	-	8.38	6.04	-	-	-	-	-
78	14.60	630	2.95	0.86	2.07	-	-	-	-	-	-	9
79	16.32	330	4.72	0.95	3.73	-	-	-	-	-	-	2
80	17.10	390	4.92	-	-	8.33	6.14	-	-	-	-	-
81	11.58	450	2.66	0.72	1.93	-	-	-	-	-	-	4
82	15.14	540	2.68	1.23	1.45	-	-	7.22	6.07	6.94	6.06	-
83	15.03	570	2.83	-	-	7.88	6.16	-	-	-	-	-
84	19.94	420	4.14	1.48	2.57	-	-	-	-	-	-	5
85	16.02	660	2.53	1.11	1.36	-	-	7.16	6.07	7.00	6.10	-
86	13.88	330	4.14	1.60	2.50	-	-	7.08	6.10	6.76	5.95	-
87	12.29	720	1.80	0.71	1.04	-	-	-	-	-	-	9
88	17.95	480	3.64	1.29	2.31	-	-	7.24	5.97	7.18	6.14	-
89	18.65	420	5.26	2.02	3.23	-	-	7.46	6.14	6.98	6.10	-
90	18.65	450	5.91	1.83	4.08	-	-	7.26	6.07	7.37	6.11	-
91	16.29	690	2.65	1.04	1.57	-	-	7.04	6.08	7.01	6.04	-
92	17.86	600	3.51	-	-	8.13	6.05	-	-	-	-	-
93	17.57	300	6.12	2.36	3.74	-	-	7.34	6.11	7.06	6.07	-
94	12.24	570	2.47	0.68	1.80	-	-	-	-	-	-	4
95	13.55	360	4.71	-	-	7.62	6.04	-	-	-	-	-
96	12.74	540	2.22	0.76	1.47	-	-	-	-	-	-	4

Appendix A.12

Replication 3 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 21°C and 82% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
97	13.85	510	3.15	1.24	1.91	-	-	6.88	6.04	6.83	6.09	-
98	14.01	540	3.15	-	-	7.69	6.06	-	-	-	-	-
99	18.13	420	5.81	2.79	3.00	-	-	7.29	5.96	6.98	6.12	-
100	19.86	330	6.86	3.82	3.04	-	-	-	-	-	-	5
101	19.36	300	7.91	3.76	4.13	-	-	7.25	6.10	6.88	5.96	-
102	15.51	630	3.76	1.80	1.91	-	-	-	-	-	-	9
103	18.36	570	3.33	-	-	8.32	6.10	-	-	-	-	-
104	15.55	270	6.75	-	-	7.85	6.14	-	-	-	-	-
105	15.12	390	6.09	-	-	7.64	6.00	-	-	-	-	-
106	17.81	690	3.06	-	-	8.08	6.11	-	-	-	-	-
107	15.65	450	4.37	2.15	2.20	-	-	7.08	5.94	6.85	6.11	-
108	14.10	660	3.60	-	-	7.68	6.13	-	-	-	-	-
109	15.39	660	2.70	1.26	1.32	-	-	-	-	-	-	9
110	16.20	600	3.39	1.33	1.93	-	-	-	-	-	-	7
111	12.68	390	4.79	2.09	2.62	-	-	-	-	-	-	1
112	12.19	510	3.65	1.28	2.34	-	-	-	-	-	-	5
113	14.13	720	3.18	-	-	7.89	6.11	-	-	-	-	-
114	14.87	300	5.36	2.10	3.22	-	-	-	-	-	-	1
115	17.64	630	2.97	1.46	1.47	-	-	7.32	6.02	6.86	6.04	-
116	14.29	420	5.09	1.99	3.06	-	-	-	-	-	-	1
117	14.67	270	7.46	3.69	3.71	-	-	7.02	6.11	6.86	6.06	-
118	15.35	360	5.14	1.97	3.17	-	-	7.02	6.02	6.86	6.10	-
119	13.78	540	3.44	0.86	2.53	-	-	-	-	-	-	7
120	14.81	480	3.39	-	-	7.56	6.04	-	-	-	-	-

Appendix A.12 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
121	12.27	600	2.93	-	-	7.63	6.03	-	-	-	-	-
122	13.35	390	4.61	2.08	2.54	-	-	7.02	6.08	6.78	6.11	-
123	11.20	720	1.70	0.91	0.76	-	-	6.90	6.07	6.67	6.12	-
124	14.80	450	4.88	-	-	7.89	6.12	-	-	-	-	-
125	13.69	570	3.90	1.56	2.30	-	-	6.96	6.02	6.75	6.04	-
126	14.07	330	5.50	1.88	3.60	-	-	6.94	6.06	6.89	6.03	-
127	11.85	270	5.15	1.45	3.61	-	-	-	-	-	-	1
128	12.52	690	3.21	1.11	2.09	-	-	6.85	6.11	6.69	6.02	-
129	13.21	510	4.07	-	-	7.53	6.10	-	-	-	-	-
130	14.01	480	3.52	1.40	2.08	-	-	-	-	-	-	5
131	15.28	360	5.12	-	-	8.04	6.07	-	-	-	-	-
132	12.48	630	2.34	-	-	7.65	6.08	-	-	-	-	-
133	11.64	480	2.48	0.86	1.57	-	-	6.88	6.05	6.64	6.05	-
134	13.08	540	4.30	0.98	3.19	-	-	6.75	6.02	7.07	6.15	-
135	13.09	420	4.64	-	-	7.83	6.03	-	-	-	-	-
136	12.33	570	2.65	1.23	1.36	-	-	-	-	-	-	7
137	12.77	600	2.96	1.51	1.37	-	-	7.07	6.09	6.76	6.11	-
138	12.14	360	4.13	1.44	2.69	-	-	-	-	-	-	5
139	17.66	330	6.12	-	-	8.31	6.07	-	-	-	-	-
140	13.07	300	5.96	-	-	7.83	6.04	-	-	-	-	-
141	11.39	720	2.16	1.21	0.96	-	-	-	-	-	-	9
142	12.75	450	3.28	1.00	2.27	-	-	-	-	-	-	5
143	10.87	660	2.11	0.81	1.30	-	-	6.81	6.13	6.66	6.08	-
144	10.22	690	1.94	0.69	1.15	-	-	-	-	-	-	9

Appendix A.13

Replication 1 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.28 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 24°C and 74% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
1	22.80	450	5.63	2.68	2.91	-	-	7.97	6.06	7.07	6.06	-
2	13.54	510	3.60	1.02	2.62	-	-	6.96	6.13	6.77	6.05	-
3	10.15	660	2.31	-	-	7.34	6.06	-	-	-	-	-
4	20.63	600	5.03	-	-	8.43	6.16	-	-	-	-	-
5	11.48	690	2.17	1.13	1.04	-	-	7.14	6.12	6.92	6.14	-
6	15.48	630	2.90	1.24	1.62	-	-	7.30	6.09	6.86	5.97	-
7	17.68	540	2.88	1.21	1.61	-	-	7.02	5.96	6.85	6.05	-
8	17.11	360	5.21	-	-	8.12	6.04	-	-	-	-	-
9	13.95	330	5.35	-	-	7.76	6.09	-	-	-	-	-
10	18.28	300	7.57	-	-	8.16	6.00	-	-	-	-	-
11	15.90	420	5.51	2.23	3.25	-	-	7.20	6.12	6.96	6.11	-
12	7.28	270	3.14	0.75	2.33	-	-	-	-	-	-	1
13	9.44	690	1.89	-	-	7.03	6.08	-	-	-	-	-
14	15.34	540	3.51	1.36	2.12	-	-	-	-	-	-	4
15	11.24	570	2.21	-	-	7.39	6.15	-	-	-	-	-
16	10.10	480	3.27	1.32	1.93	-	-	-	-	-	-	3
17	8.07	720	2.24	0.32	1.91	-	-	-	-	-	-	9
18	12.03	630	2.97	0.75	2.14	-	-	-	-	-	-	9
19	11.06	270	4.88	-	-	7.37	5.95	-	-	-	-	-
20	12.95	390	3.16	0.96	2.19	-	-	-	-	-	-	2
21	10.89	360	4.30	2.27	1.93	-	-	6.87	6.00	6.66	6.14	-
22	13.03	510	3.21	-	-	7.69	6.12	-	-	-	-	-
23	8.74	420	2.65	0.94	1.77	-	-	-	-	-	-	3
24	13.79	330	4.99	2.38	2.63	-	-	7.25	6.18	6.79	6.05	-

Appendix A.13 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	12.51	450	3.54	-	-	7.60	6.12	-	-	-	-	-
26	9.15	300	3.28	1.28	1.95	-	-	7.06	6.05	6.94	5.96	-
27	17.34	480	4.37	1.55	2.82	-	-	7.25	6.12	7.01	6.17	-
28	12.57	630	2.47	-	-	7.47	6.11	-	-	-	-	-
29	11.34	540	2.72	-	-	7.51	5.99	-	-	-	-	-
30	18.29	570	4.64	1.61	3.06	-	-	7.37	6.14	7.06	6.04	-
31	17.39	420	5.85	-	-	8.03	6.08	-	-	-	-	-
32	14.50	270	5.17	1.95	3.28	-	-	7.10	6.02	6.89	6.11	-
33	17.98	390	4.71	2.05	2.60	-	-	7.35	6.10	6.85	6.09	-
34	10.59	720	2.24	0.70	1.55	-	-	6.71	6.09	6.77	5.99	-
35	9.18	660	1.53	0.60	0.94	-	-	6.63	6.02	6.72	6.12	-
36	13.65	600	2.59	0.85	1.70	-	-	-	-	-	-	4
37	20.04	330	7.68	3.65	4.00	-	-	-	-	-	-	1
38	9.17	480	2.84	-	-	7.19	6.10	-	-	-	-	-
39	6.95	690	1.72	0.29	1.39	-	-	-	-	-	-	9
40	14.38	570	2.72	0.88	1.81	-	-	-	-	-	-	4
41	10.71	600	2.14	0.72	1.39	-	-	6.75	6.04	6.63	6.04	-
42	8.56	720	2.18	0.00	-	7.27	6.15	-	-	-	-	-
43	11.69	300	4.98	1.77	3.30	-	-	-	-	-	-	1
44	7.77	510	2.01	0.55	1.45	-	-	-	-	-	-	3
45	16.80	360	7.25	3.66	3.54	-	-	-	-	-	-	2
46	14.66	450	5.14	1.49	3.59	-	-	-	-	-	-	3
47	6.59	660	2.00	0.23	1.78	-	-	-	-	-	-	9
48	9.89	390	3.04	-	-	7.44	6.14	-	-	-	-	-

Appendix A.14

Replication 2 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 24°C and 74% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying			PDE Code			
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)		Receptacle Weight (grams)	Tare (grams)	
49	9.80	720	1.40	0.64	0.73	-	-	6.69	6.10	6.84	6.16	-
50	17.83	570	3.16	1.21	1.95	-	-	7.30	6.15	7.17	6.14	-
51	11.54	600	1.61	0.72	0.84	-	-	6.78	6.02	6.65	6.10	-
52	8.08	630	1.34	-	-	7.23	6.06	-	-	-	-	-
53	20.15	330	3.53	-	-	8.33	6.05	-	-	-	-	-
54	8.89	420	1.52	0.51	0.95	-	-	6.66	6.06	6.74	6.16	-
55	12.50	270	3.93	0.68	3.21	-	-	6.66	6.04	7.12	6.11	-
56	15.32	720	1.20	0.56	0.62	-	-	-	-	-	-	9
57	15.98	450	2.10	1.21	0.90	-	-	7.29	6.09	6.74	5.96	-
58	7.81	660	1.04	-	-	7.06	6.09	-	-	-	-	-
59	10.72	390	2.07	-	-	7.53	6.11	-	-	-	-	-
60	10.24	300	3.63	-	-	7.60	6.11	-	-	-	-	-
61	14.32	480	3.31	-	-	7.96	6.09	-	-	-	-	-
62	11.44	690	1.52	-	-	7.57	6.16	-	-	-	-	-
63	10.76	660	1.37	0.74	0.56	-	-	6.87	6.08	6.65	6.08	-
64	9.70	420	2.89	0.58	2.27	-	-	-	-	-	-	3
65	24.77	360	5.14	2.17	2.95	-	-	7.60	6.12	6.95	6.07	-
66	13.63	510	2.42	0.85	1.53	-	-	6.84	6.11	6.80	6.17	-
67	6.80	300	2.71	0.60	2.11	-	-	6.51	6.08	6.50	5.93	-
68	5.90	540	1.56	-	-	6.84	6.11	-	-	-	-	-
69	5.31	270	2.19	-	-	6.73	6.05	-	-	-	-	-
70	9.89	630	2.01	0.65	1.34	-	-	-	-	-	-	9
71	15.46	600	2.72	1.10	1.59	-	-	-	-	-	-	9
72	4.68	390	1.26	0.44	0.84	-	-	-	-	-	-	3

Appendix A.14 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
73	7.34	720	0.98	-	-	6.94	6.09	-	-	-	-	-
74	16.59	360	4.52	-	-	8.21	6.15	-	-	-	-	-
75	17.85	330	4.02	1.24	2.78	-	-	-	-	-	-	3
76	7.77	690	1.00	0.48	0.47	-	-	6.58	6.14	6.45	6.05	-
77	10.90	630	1.34	0.76	0.54	-	-	6.82	6.05	6.60	6.00	-
78	7.25	570	1.54	-	-	7.18	6.15	-	-	-	-	-
79	5.90	270	2.10	0.37	1.69	-	-	-	-	-	-	2
80	24.22	390	4.70	1.77	2.98	-	-	7.69	6.02	7.23	6.04	-
81	7.86	450	1.94	1.54	1.54	-	-	-	-	-	-	3
82	16.90	540	2.49	1.42	1.42	-	-	-	-	-	-	4
83	11.93	480	2.42	1.80	1.80	-	-	-	-	-	-	4
84	13.68	510	2.41	1.64	1.64	-	-	-	-	-	-	4
85	13.94	420	2.51	-	-	7.80	6.07	-	-	-	-	-
86	7.10	600	1.11	-	-	7.09	6.16	-	-	-	-	-
87	21.09	330	3.35	1.82	1.82	-	-	7.45	6.06	6.97	6.08	-
88	8.32	360	1.62	0.94	0.94	-	-	-	-	-	-	3
89	9.65	300	3.70	2.68	2.68	-	-	-	-	-	-	2
90	10.22	450	2.78	-	-	7.46	6.00	-	-	-	-	-
91	11.96	480	2.93	2.06	2.06	-	-	6.89	6.07	6.82	6.11	-
92	17.78	660	2.81	1.63	1.63	-	-	-	-	-	-	9
93	10.31	540	2.96	2.38	2.38	-	-	6.65	6.13	6.96	6.06	-
94	19.92	570	3.60	2.14	2.14	-	-	-	-	-	-	9
95	10.89	510	2.12	-	-	8.70	6.20	-	-	-	-	-
96	9.02	690	1.12	0.42	0.42	-	-	-	-	-	-	9

Appendix A.15

Replication 3 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 24°C and 74% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
97	13.97	570	2.12	-	-	7.49	6.04	-	-	-	-	-
98	14.40	420	3.83	-	-	7.77	6.13	-	-	-	-	-
99	7.73	450	2.41	-	-	7.00	6.18	-	-	-	-	-
100	10.41	720	1.72	0.62	1.10	-	-	6.73	6.14	6.64	6.03	-
101	4.69	390	1.72	0.31	1.43	-	-	6.23	6.00	6.59	6.09	-
102	14.17	330	4.84	1.85	2.98	-	-	-	-	-	-	1
103	13.88	360	6.36	2.45	3.91	-	-	-	-	-	-	1
104	6.85	630	1.41	-	-	6.78	6.01	-	-	-	-	-
105	13.42	660	1.83	0.84	1.02	-	-	-	-	-	-	4
106	8.76	540	2.70	-	-	7.08	6.05	-	-	-	-	-
107	12.53	300	6.25	3.10	3.11	-	-	-	-	-	-	1
108	14.53	510	6.47	-	-	7.88	6.08	-	-	-	-	-
109	9.56	390	3.74	-	-	7.24	6.06	-	-	-	-	-
110	17.82	480	6.48	-	-	8.07	6.11	-	-	-	-	-
111	11.94	330	6.21	-	-	7.68	6.04	-	-	-	-	-
112	6.73	300	3.24	-	-	7.15	6.15	-	-	-	-	-
113	10.09	270	4.98	-	-	7.57	6.13	-	-	-	-	-
114	13.72	540	4.52	1.49	3.01	-	-	6.93	6.09	6.79	6.10	-
115	10.21	600	2.35	-	-	7.31	6.02	-	-	-	-	-
116	11.90	630	2.75	0.67	2.02	-	-	6.65	5.98	6.94	6.05	-
117	10.02	690	1.97	-	-	7.22	6.09	-	-	-	-	-
118	12.40	570	4.02	1.46	2.60	-	-	6.88	6.04	6.79	6.12	-
119	13.56	360	4.30	-	-	7.87	6.25	-	-	-	-	-
120	20.52	660	4.78	-	-	8.60	6.15	-	-	-	-	-

Appendix A.15 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
121	14.28	690	2.39	1.04	1.29	-	-	7.08	6.07	6.87	6.08	-
122	10.15	450	2.82	0.88	1.83	-	-	6.57	5.97	6.57	6.09	-
123	15.14	330	5.66	3.05	2.56	-	-	7.06	6.06	6.56	6.00	-
124	10.88	600	3.51	1.19	2.33	-	-	6.74	6.01	6.77	6.20	-
125	5.06	300	2.20	0.44	1.82	-	-	6.20	5.94	6.48	6.14	-
126	4.09	480	1.48	0.25	1.23	-	-	-	-	-	-	3
127	15.01	270	6.58	2.19	4.35	-	-	6.98	6.22	6.76	6.08	-
128	7.96	720	2.05	0.57	1.48	-	-	-	-	-	-	9
129	11.14	540	3.71	0.86	2.70	-	-	-	-	-	-	3
130	9.36	510	3.58	0.64	2.81	-	-	6.54	5.91	6.88	6.11	-
131	10.71	660	2.57	0.76	1.83	-	-	6.63	5.97	6.68	6.10	-
132	10.95	420	3.75	0.73	2.86	-	-	-	-	-	-	2
133	15.01	600	3.49	1.01	2.52	-	-	-	-	-	-	4
134	9.21	570	2.96	0.64	2.38	-	-	-	-	-	-	3
135	9.09	510	3.19	0.41	2.67	-	-	-	-	-	-	3
136	20.77	630	5.69	1.51	4.07	-	-	-	-	-	-	4
137	8.47	420	3.45	1.39	1.92	-	-	6.71	6.11	6.50	5.93	-
138	7.06	690	2.12	0.46	1.66	-	-	-	-	-	-	9
139	11.37	390	4.75	1.39	3.32	-	-	-	-	-	-	2
140	6.53	720	0.94	-	-	6.69	6.06	-	-	-	-	-
141	9.47	360	4.08	2.00	2.08	-	-	6.69	6.05	6.46	6.06	-
142	6.35	270	2.88	0.94	2.00	-	-	-	-	-	-	1
143	7.57	480	2.00	0.48	1.51	-	-	6.52	6.10	6.69	6.05	-
144	8.64	450	2.76	0.46	2.16	-	-	-	-	-	-	2

Appendix A.16

Replication 1 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 81% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
1	21.42	630	4.89	-	-	8.61	6.01	-	-	-	-	-
2	19.51	510	4.63	1.09	3.48	-	-	-	-	-	-	4
3	14.49	540	3.06	0.94	2.11	-	-	-	-	-	-	4
4	12.39	720	2.69	-	-	7.53	6.07	-	-	-	-	-
5	20.33	570	3.70	-	-	8.16	6.02	-	-	-	-	-
6	20.70	450	4.46	-	-	8.40	6.08	-	-	-	-	-
7	12.66	300	4.63	0.82	3.80	-	-	-	-	-	-	3
8	23.00	660	5.25	-	-	8.84	6.10	-	-	-	-	-
9	16.95	360	4.97	-	-	8.10	6.07	-	-	-	-	-
10	11.89	270	4.65	-	-	7.54	6.05	-	-	-	-	-
11	12.09	330	4.05	-	-	7.37	6.04	-	-	-	-	-
12	17.56	390	3.11	-	-	7.89	6.07	-	-	-	-	-
13	24.08	420	5.73	1.82	3.84	-	-	-	-	-	-	3
14	8.95	600	2.70	0.37	2.27	-	-	-	-	-	-	4
15	7.12	690	1.53	-	-	6.88	6.15	-	-	-	-	-
16	13.73	300	4.20	-	-	7.68	6.14	-	-	-	-	-
17	19.93	570	4.94	1.20	3.60	-	-	-	-	-	-	4
18	11.85	480	3.70	0.75	2.90	-	-	6.73	6.04	6.86	6.12	-
19	7.89	510	2.36	0.54	1.84	-	-	6.30	5.99	6.69	6.18	-
20	9.73	630	2.43	0.49	1.95	-	-	-	-	-	-	4
21	17.07	330	4.36	1.78	2.54	-	-	-	-	-	-	3
22	12.06	450	2.41	0.72	1.69	-	-	-	-	-	-	3
23	4.75	720	1.14	0.25	0.85	-	-	6.31	6.08	6.33	6.03	-
24	10.52	360	4.34	0.81	3.43	-	-	-	-	-	-	3

Appendix A.16 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
25	12.50	330	4.40	1.17	3.17	-	-	6.69	6.14	6.62	6.09	-
26	4.15	720	0.57	0.27	0.28	-	-	-	-	-	-	9
27	14.52	480	3.94	0.82	3.10	-	-	-	-	-	-	4
28	20.23	540	5.92	-	-	8.35	6.07	-	-	-	-	-
29	10.71	600	2.73	0.58	2.05	-	-	6.52	5.95	6.65	6.10	-
30	11.57	390	1.86	0.71	1.16	-	-	-	-	-	-	3
31	17.90	420	4.75	-	-	7.83	6.00	-	-	-	-	-
32	10.05	660	1.95	0.53	1.33	-	-	-	-	-	-	9
33	23.88	510	6.63	-	-	9.09	6.08	-	-	-	-	-
34	11.29	450	2.59	0.60	1.95	-	-	6.70	6.07	6.92	6.09	-
35	9.87	690	1.81	0.42	1.46	-	-	-	-	-	-	9
36	8.47	270	3.73	0.67	3.02	-	-	-	-	-	-	2
37	12.10	630	2.23	0.71	1.50	-	-	6.80	6.01	6.82	6.03	-
38	7.03	420	2.29	0.39	1.90	-	-	6.45	6.06	6.56	6.05	-
39	8.74	390	3.12	0.46	2.62	-	-	6.50	6.08	6.81	6.05	-
40	15.01	480	3.39	-	-	8.07	6.06	-	-	-	-	-
41	24.94	300	8.10	3.30	4.75	-	-	7.79	6.11	7.27	6.06	-
42	8.94	270	4.30	1.33	2.83	-	-	6.77	6.14	6.63	6.07	-
43	10.82	600	2.40	-	-	7.50	6.04	-	-	-	-	-
44	21.48	540	4.23	1.34	2.61	-	-	7.33	6.11	7.16	6.04	-
45	9.47	690	2.16	0.49	1.62	-	-	6.49	6.08	6.80	6.16	-
46	8.82	660	2.83	0.42	2.31	-	-	6.45	6.04	6.75	6.08	-
47	12.89	570	2.49	0.70	1.73	-	-	6.77	6.08	6.73	6.07	-
48	17.41	360	5.39	1.48	3.90	-	-	7.18	6.12	6.96	6.12	-

Appendix A.17

Replication 2 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 81% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	Tare (grams)
49	13.93	330	3.39	0.87	2.50	-	-	-	-	-	-	3
50	12.52	360	4.65	0.85	3.79	-	-	6.75	6.11	6.87	6.02	-
51	13.04	390	4.67	0.79	3.80	-	-	6.82	6.05	6.91	6.05	-
52	19.22	420	5.30	-	-	8.35	6.10	-	-	-	-	-
53	19.50	450	3.45	1.28	2.19	-	-	-	-	-	-	4
54	12.47	300	5.01	0.79	4.13	-	-	6.78	6.14	6.96	6.06	-
55	19.32	540	2.82	-	-	8.18	6.06	-	-	-	-	-
56	5.62	720	1.00	0.32	0.64	-	-	-	-	-	-	9
57	19.49	480	2.41	-	-	8.07	6.16	-	-	-	-	-
58	7.46	630	1.67	0.45	1.25	-	-	-	-	-	-	4
59	13.78	600	2.48	0.66	1.76	-	-	6.81	6.18	7.01	5.96	-
60	9.92	690	2.30	0.61	1.62	-	-	6.66	6.05	6.78	6.01	-
61	12.38	360	3.24	-	-	7.56	6.04	-	-	-	-	-
62	14.43	480	2.32	1.02	1.33	-	-	-	-	-	-	4
63	9.53	720	1.62	-	-	7.39	6.23	-	-	-	-	-
64	7.98	510	1.30	0.33	0.99	-	-	-	-	-	-	4
65	9.99	570	2.80	0.43	2.27	-	-	6.52	6.06	6.68	5.94	-
66	13.90	540	3.73	0.76	2.86	-	-	6.83	6.10	6.83	6.07	-
67	11.86	330	4.44	-	-	7.42	6.05	-	-	-	-	-
68	10.86	660	1.28	-	-	7.25	6.02	-	-	-	-	-
69	9.89	300	3.15	-	-	7.33	6.18	-	-	-	-	-
70	18.86	450	3.44	1.15	2.28	-	-	7.20	6.12	7.16	6.08	-
71	9.09	690	1.43	-	-	7.29	6.14	-	-	-	-	-
72	12.88	270	5.19	-	-	7.66	6.09	-	-	-	-	-

Appendix A.17 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	8.91	600	1.12	0.46	0.49	-	-	-	-	-	-	4
74	17.37	360	2.66	1.16	1.56	-	-	-	-	-	-	3
75	16.52	390	3.23	1.01	2.10	-	-	-	-	-	-	3
76	8.09	660	1.15	0.47	0.74	-	-	6.48	6.05	6.72	6.10	-
77	14.16	300	4.09	0.93	3.19	-	-	-	-	-	-	3
78	9.31	570	1.81	-	-	7.33	6.17	-	-	-	-	-
79	8.96	630	1.54	0.42	1.11	-	-	6.63	6.21	6.83	6.05	-
80	18.73	270	4.80	1.21	3.58	-	-	7.14	6.04	7.13	6.11	-
81	19.29	540	3.51	1.07	2.40	-	-	-	-	-	-	4
82	15.81	420	3.00	0.86	2.03	-	-	-	-	-	-	3
83	11.25	720	1.41	0.54	0.80	-	-	6.60	6.04	6.59	6.00	-
84	14.19	510	2.72	-	-	7.60	6.11	-	-	-	-	-
85	18.67	480	3.02	1.25	1.81	-	-	7.19	6.06	6.91	6.06	-
86	17.06	390	4.00	-	-	8.12	6.11	-	-	-	-	-
87	9.04	660	1.47	0.50	0.97	-	-	-	-	-	-	9
88	9.07	510	2.10	0.47	1.66	-	-	6.51	6.10	6.79	6.12	-
89	19.85	420	4.24	1.32	2.84	-	-	7.30	6.18	6.98	6.04	-
90	7.90	570	1.55	0.45	1.02	-	-	-	-	-	-	4
91	11.74	270	4.30	0.89	3.39	-	-	-	-	-	-	3
92	15.36	600	2.08	-	-	7.77	5.93	-	-	-	-	-
93	14.78	330	3.55	1.08	2.45	-	-	6.79	6.09	6.70	6.14	-
94	11.43	630	2.26	-	-	7.50	6.16	-	-	-	-	-
95	8.92	690	1.04	0.49	0.53	-	-	-	-	-	-	9
96	20.88	450	3.22	-	-	8.14	6.11	-	-	-	-	-

Appendix A.18

Replication 3 data for thin-layer drying at an air temperature of 60°C and an airflow of 0.33 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 81% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying					PDE Code	
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
97	7.15	720	1.53	-	-	6.84	6.05	-	-	-	-	-
98	8.91	360	2.63	0.47	2.11	-	-	-	-	-	-	3
99	7.76	570	2.55	0.39	2.21	-	-	-	-	-	-	4
100	18.33	540	4.37	1.16	3.12	-	-	-	-	-	-	4
101	14.77	600	3.84	0.66	3.04	-	-	6.77	6.05	6.85	6.06	-
102	23.11	510	7.08	2.23	4.89	-	-	7.30	6.06	7.25	6.01	-
103	13.08	300	4.32	0.89	3.42	-	-	-	-	-	-	3
104	10.42	630	2.81	0.63	2.14	-	-	-	-	-	-	9
105	11.79	450	3.62	0.75	2.84	-	-	6.83	6.13	6.97	6.14	-
106	7.58	690	2.34	0.46	1.88	-	-	-	-	-	-	9
107	9.40	330	4.62	-	-	7.16	5.95	-	-	-	-	-
108	12.63	420	4.31	1.31	2.99	-	-	6.78	6.03	6.81	6.10	-
109	9.62	690	1.52	-	-	7.22	6.09	-	-	-	-	-
110	16.70	450	4.83	1.10	3.73	-	-	-	-	-	-	4
111	15.95	360	4.99	-	-	8.07	6.06	-	-	-	-	-
112	20.28	480	4.76	-	-	8.20	6.10	-	-	-	-	-
113	10.51	690	3.10	0.48	2.50	-	-	-	-	-	-	9
114	9.39	510	3.15	0.53	2.60	-	-	-	-	-	-	4
115	13.97	570	3.44	0.97	2.44	-	-	6.78	5.99	6.76	6.07	-
116	12.96	390	5.45	-	-	7.58	5.96	-	-	-	-	-
117	19.69	540	4.28	-	-	7.90	6.00	-	-	-	-	-
118	10.08	330	3.21	0.52	2.68	-	-	-	-	-	-	3
119	9.80	600	1.84	0.55	1.12	-	-	-	-	-	-	4
120	12.03	270	5.48	1.31	4.25	-	-	6.76	6.11	7.09	6.16	-

Appendix A.18 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
121	18.13	540	4.11	1.17	2.90	-	-	7.03	6.00	7.38	6.12	-
122	9.85	300	4.31	-	-	7.32	6.09	-	-	-	-	-
123	24.91	570	8.63	-	-	8.49	5.96	-	-	-	-	-
124	13.99	480	3.03	1.14	1.84	-	-	6.79	6.05	6.54	5.99	-
125	14.46	690	2.88	0.96	1.84	-	-	6.82	6.02	6.65	6.08	-
126	12.93	390	4.94	1.14	3.75	-	-	6.72	6.17	6.88	6.01	-
127	21.95	450	4.69	-	-	8.39	6.14	-	-	-	-	-
128	8.82	690	0.87	0.38	0.40	-	-	6.52	6.12	6.40	6.09	-
129	8.48	630	1.92	0.45	1.48	-	-	6.49	6.10	6.57	5.97	-
130	11.38	270	3.11	-	-	7.29	6.12	-	-	-	-	-
131	12.47	420	2.29	0.87	1.39	-	-	-	-	-	-	3
132	7.43	720	1.64	0.28	1.31	-	-	-	-	-	-	9
133	17.83	420	5.76	-	-	8.27	6.07	-	-	-	-	-
134	17.32	510	4.14	-	-	7.81	6.02	-	-	-	-	-
135	11.67	300	4.02	0.72	3.29	-	-	6.66	6.05	6.88	6.10	-
136	14.00	600	4.30	-	-	7.67	6.02	-	-	-	-	-
137	12.16	270	6.12	2.06	4.06	-	-	-	-	-	-	3
138	16.84	480	4.61	1.51	3.11	-	-	-	-	-	-	4
139	9.92	390	4.04	0.96	3.04	-	-	-	-	-	-	3
140	14.94	630	3.94	-	-	7.78	6.23	-	-	-	-	-
141	8.91	720	2.25	0.85	1.44	-	-	6.51	6.01	6.31	6.03	-
142	8.85	360	2.72	0.51	2.13	-	-	6.58	6.07	6.73	6.02	-
143	8.45	330	3.75	0.35	3.22	-	-	6.41	6.01	6.78	6.00	-
144	16.41	690	3.43	-	-	8.00	6.04	-	-	-	-	-

Appendix A.19

Replication 1 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 69% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
1	12.36	480	2.81	0.81	2.00	-	-	-	-	-	-	4
2	12.57	300	4.22	1.12	2.96	-	-	6.85	6.05	6.80	6.13	-
3	12.87	330	4.06	-	-	7.68	6.08	-	-	-	-	-
4	12.90	390	3.55	-	-	7.73	5.97	-	-	-	-	-
5	16.40	150	7.82	3.79	4.00	-	-	7.26	6.06	6.81	6.03	-
6	11.32	360	3.98	-	-	7.56	6.16	-	-	-	-	-
7	20.39	210	11.10	-	-	8.63	6.14	-	-	-	-	-
8	17.29	180	9.72	4.91	4.75	-	-	7.25	6.10	6.92	6.03	-
9	15.40	270	3.95	1.26	2.66	-	-	7.17	6.05	6.95	6.07	-
10	13.58	570	2.40	0.91	1.47	-	-	-	-	-	-	9
11	14.44	450	2.82	-	-	7.87	6.06	-	-	-	-	-
12	13.44	600	2.09	-	-	7.79	6.07	-	-	-	-	-
13	19.31	450	4.80	1.56	3.21	-	-	7.35	6.15	7.04	6.05	-
14	16.27	420	4.77	-	-	8.02	5.92	-	-	-	-	-
15	14.46	510	3.19	1.32	1.87	-	-	7.09	6.02	6.93	6.12	-
16	17.96	600	3.02	1.55	1.48	-	-	7.50	6.08	6.98	6.04	-
17	12.90	210	4.73	1.75	2.95	-	-	-	-	-	-	2
18	11.18	570	2.52	-	-	7.63	6.08	-	-	-	-	-
19	17.45	180	9.70	-	-	8.22	6.10	-	-	-	-	-
20	12.28	330	4.48	1.94	2.48	-	-	6.97	6.05	6.90	6.10	-
21	12.86	300	4.01	-	-	7.54	5.98	-	-	-	-	-
22	13.70	240	6.81	3.04	3.65	-	-	-	-	-	-	2
23	18.02	360	6.46	3.29	3.12	-	-	7.27	6.00	6.87	6.03	-
24	15.44	480	4.38	-	-	7.88	6.06	-	-	-	-	-

Appendix A.19 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	12.59	270	4.83	1.11	3.64	-	-	-	-	-	-	3
26	12.98	390	3.26	1.24	1.94	-	-	7.10	6.08	6.77	6.02	-
27	12.46	510	1.96	0.98	0.98	-	-	-	-	-	-	4
28	13.81	240	4.45	-	-	7.73	6.07	-	-	-	-	-
29	12.49	420	3.49	1.31	2.07	-	-	7.06	6.13	6.71	6.07	-
30	18.05	480	5.12	3.03	2.11	-	-	7.45	6.05	6.78	6.04	-
31	12.64	330	4.46	1.90	2.60	-	-	-	-	-	-	3
32	12.93	570	2.66	0.77	1.84	-	-	6.84	6.06	6.82	6.04	-
33	12.88	360	3.96	1.11	2.81	-	-	-	-	-	-	3
34	11.73	540	3.24	1.75	1.47	-	-	6.96	6.11	6.55	6.02	-
35	13.06	150	7.75	3.62	4.07	-	-	-	-	-	-	1
36	14.92	210	6.14	2.39	3.71	-	-	7.14	6.09	6.73	5.98	-
37	14.27	450	3.82	0.81	2.98	-	-	-	-	-	-	4
38	16.74	270	6.81	-	-	8.17	6.12	-	-	-	-	-
39	12.13	540	2.62	0.86	1.76	-	-	-	-	-	-	4
40	10.90	300	2.71	0.61	2.04	-	-	-	-	-	-	3
41	11.28	180	5.89	2.15	3.72	-	-	-	-	-	-	2
42	10.73	420	3.03	1.25	1.82	-	-	-	-	-	-	3
43	12.03	150	5.33	-	-	7.68	6.12	-	-	-	-	-
44	14.96	510	3.28	-	-	7.96	6.04	-	-	-	-	-
45	11.09	600	1.69	0.89	0.80	-	-	-	-	-	-	9
46	16.56	390	4.24	1.60	2.59	-	-	-	-	-	-	3
47	15.67	240	5.20	1.51	3.62	-	-	7.08	6.06	6.95	6.12	-
48	14.53	540	2.62	-	-	7.88	6.03	-	-	-	-	-

Appendix A.20

Replication 2 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.23 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 69% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
49	13.06	360	2.51	-	-	7.60	6.08	-	-	-	-	-
50	19.44	150	8.78	-	-	8.40	6.09	-	-	-	-	-
51	13.91	270	4.85	1.72	3.09	-	-	7.10	6.07	6.87	6.10	-
52	11.89	540	2.10	0.78	1.30	-	-	-	-	-	-	4
53	12.52	480	2.39	0.86	1.59	-	-	-	-	-	-	4
54	15.03	450	3.76	-	-	7.96	6.23	-	-	-	-	-
55	17.05	240	7.03	3.23	3.76	-	-	-	-	-	-	2
56	12.29	300	3.80	0.95	2.81	-	-	6.84	6.08	6.66	6.10	-
57	13.98	420	2.33	-	-	7.79	6.05	-	-	-	-	-
58	9.76	600	1.24	-	-	7.20	6.00	-	-	-	-	-
59	14.63	180	5.77	-	-	7.91	6.13	-	-	-	-	-
60	20.95	540	3.62	-	-	8.74	6.04	-	-	-	-	-
61	15.27	450	2.40	0.91	1.50	-	-	-	-	-	-	3
62	9.82	600	1.26	0.65	0.59	-	-	6.77	6.05	6.55	5.99	-
63	9.36	210	3.22	0.48	2.66	-	-	6.68	6.13	6.59	5.98	-
64	12.24	330	2.86	1.02	1.72	-	-	-	-	-	-	3
65	14.44	150	5.07	1.19	3.78	-	-	7.02	6.12	6.93	6.15	-
66	12.70	180	4.91	1.48	3.41	-	-	-	-	-	-	2
67	13.89	270	4.43	1.40	2.98	-	-	-	-	-	-	2
68	14.45	360	3.60	0.84	2.66	-	-	-	-	-	-	3
69	12.84	480	2.18	-	-	7.65	6.10	-	-	-	-	-
70	14.30	300	4.03	1.05	2.79	-	-	-	-	-	-	2
71	14.72	570	3.18	1.42	1.73	-	-	7.04	6.01	6.85	6.04	-
72	13.88	390	2.89	-	-	7.73	6.07	-	-	-	-	-

Appendix A.20 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	16.29	300	3.85	-	-	8.10	6.16	-	-	-	-	-
74	16.72	210	6.10	-	-	8.06	6.12	-	-	-	-	-
75	11.01	480	1.60	0.70	0.90	-	-	6.71	6.01	6.71	6.08	-
76	14.23	510	2.23	0.92	1.25	-	-	7.05	6.06	6.83	6.05	-
77	12.57	240	4.04	1.12	2.94	-	-	6.98	6.10	6.78	5.98	-
78	12.95	180	5.06	1.51	3.58	-	-	6.87	6.04	6.83	6.10	-
79	14.75	390	4.01	1.32	2.69	-	-	7.15	6.10	6.98	6.05	-
80	11.85	330	2.70	0.81	1.95	-	-	6.82	6.10	6.57	6.00	-
81	15.82	420	2.90	1.34	1.57	-	-	7.34	6.10	6.69	5.94	-
82	11.09	510	2.69	0.76	1.89	-	-	-	-	-	-	4
83	11.05	540	2.17	0.76	1.41	-	-	6.80	6.18	6.59	6.05	-
84	15.41	570	2.97	1.09	1.84	-	-	-	-	-	-	4
85	12.58	360	3.13	0.86	2.16	-	-	6.91	6.12	6.67	6.01	-
86	15.02	510	3.01	-	-	7.91	6.10	-	-	-	-	-
87	12.65	210	5.80	2.43	3.30	-	-	-	-	-	-	2
88	11.67	600	2.10	0.77	1.29	-	-	-	-	-	-	9
89	11.45	420	2.40	1.01	1.30	-	-	-	-	-	-	3
90	16.25	270	6.58	-	-	8.11	6.11	-	-	-	-	-
91	11.52	240	4.74	-	-	7.49	6.09	-	-	-	-	-
92	19.45	330	4.89	-	-	8.40	6.06	-	-	-	-	-
93	13.97	390	2.87	1.08	1.74	-	-	-	-	-	-	3
94	14.48	450	3.64	1.02	2.58	-	-	6.94	6.05	6.82	6.02	-
95	9.70	150	4.18	1.66	2.50	-	-	-	-	-	-	1
96	9.58	570	1.20	-	-	7.24	6.09	-	-	-	-	-

Appendix A.21

Replication 3 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 69% respectively.

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
97	12.64	180	5.13	1.71	3.40	-	-	-	-	-	-	1
98	16.98	480	4.56	2.25	2.36	-	-	-	-	-	-	3
99	11.80	360	3.62	-	-	7.53	6.05	-	-	-	-	-
100	16.41	450	4.27	1.20	3.10	-	-	-	-	-	-	3
101	13.30	570	2.91	0.94	1.99	-	-	6.91	6.08	6.84	6.02	-
102	12.84	270	5.89	-	-	7.66	6.09	-	-	-	-	-
103	11.56	600	3.14	-	-	7.52	6.06	-	-	-	-	-
104	13.56	300	5.36	1.87	3.25	-	-	6.98	6.06	6.86	6.21	-
105	14.86	510	3.88	1.40	2.51	-	-	-	-	-	-	4
106	12.31	150	6.24	3.07	3.17	-	-	-	-	-	-	1
107	13.68	240	6.69	2.83	3.93	-	-	7.04	6.08	6.84	6.18	-
108	11.93	390	2.79	0.80	1.87	-	-	6.84	6.07	6.69	6.08	-
109	14.93	420	3.74	-	-	8.07	6.08	-	-	-	-	-
110	16.31	180	8.10	2.66	5.33	-	-	7.09	6.08	6.91	6.05	-
111	18.21	210	10.04	5.00	4.99	-	-	-	-	-	-	2
112	15.44	570	3.61	-	-	7.88	6.10	-	-	-	-	-
113	14.43	480	4.25	-	-	7.73	6.05	-	-	-	-	-
114	13.42	150	7.54	2.44	5.10	-	-	6.74	6.03	7.01	6.12	-
115	15.08	450	5.27	2.59	2.69	-	-	7.10	6.06	6.74	6.05	-
116	13.01	540	2.95	0.80	2.08	-	-	-	-	-	-	4
117	12.48	330	3.32	-	-	7.55	6.08	-	-	-	-	-
118	14.08	300	5.60	2.16	3.45	-	-	-	-	-	-	2
119	17.43	270	8.22	4.18	3.94	-	-	7.30	6.07	6.91	6.06	-
120	15.05	390	4.16	-	-	8.06	6.14	-	-	-	-	-

Appendix A.21 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
121	18.46	390	4.99	1.34	3.55	-	-	-	-	-	-	3
122	17.64	300	5.69	-	-	8.21	6.05	-	-	-	-	-
123	11.67	240	4.78	-	-	7.56	6.15	-	-	-	-	-
124	12.87	540	3.11	0.73	2.27	-	-	6.86	6.10	6.90	6.11	-
125	11.57	330	3.24	0.92	2.30	-	-	6.89	6.08	6.82	6.12	-
126	13.72	600	2.82	1.26	1.55	-	-	-	-	-	-	4
127	18.75	210	10.15	-	-	8.28	6.04	-	-	-	-	-
128	11.93	360	3.44	1.24	2.19	-	-	6.79	5.99	6.76	6.12	-
129	13.89	510	2.68	-	-	7.72	6.03	-	-	-	-	-
130	14.60	480	4.38	2.07	2.31	-	-	7.16	6.03	6.71	6.03	-
131	14.23	180	7.17	-	-	7.68	6.03	-	-	-	-	-
132	12.26	420	3.20	1.54	1.62	-	-	7.03	6.08	6.61	6.06	-
133	17.33	510	3.92	1.22	2.69	-	-	7.07	6.01	7.03	6.10	-
134	15.05	420	4.16	1.26	2.83	-	-	-	-	-	-	3
135	13.72	540	3.37	-	-	7.71	6.03	-	-	-	-	-
136	12.47	570	2.13	0.84	1.17	-	-	-	-	-	-	4
137	12.32	360	4.51	1.54	2.90	-	-	-	-	-	-	3
138	16.00	240	8.57	3.22	5.27	-	-	-	-	-	-	2
139	13.99	270	5.80	2.41	3.27	-	-	-	-	-	-	2
140	14.94	330	5.19	1.56	3.57	-	-	-	-	-	-	2
141	12.85	150	8.42	-	-	7.57	6.16	-	-	-	-	-
142	13.11	450	3.01	-	-	7.49	5.98	-	-	-	-	-
143	9.93	600	2.59	0.70	1.89	-	-	6.61	6.08	6.47	5.98	-
144	15.68	210	8.39	4.51	3.81	-	-	7.07	6.00	6.66	5.94	-

Appendix A.22

Replication 1 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.28 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 76% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
1	27.08	570	6.30	2.47	3.77	-	-	8.04	5.98	7.15	6.03	-
2	15.19	390	4.15	-	-	7.92	6.06	-	-	-	-	-
3	15.80	300	4.64	1.38	3.27	-	-	7.15	6.12	6.94	6.00	-
4	14.17	420	3.61	-	-	7.85	6.08	-	-	-	-	-
5	13.15	240	5.34	1.44	3.86	-	-	6.87	6.14	7.02	6.07	-
6	13.57	270	4.24	1.32	2.83	-	-	6.90	6.06	6.65	6.02	-
7	17.70	540	2.69	1.24	1.45	-	-	7.22	6.05	6.92	6.04	-
8	14.00	180	5.14	1.44	3.77	-	-	6.87	5.93	6.93	6.05	-
9	16.02	600	2.14	-	-	7.97	6.04	-	-	-	-	-
10	15.91	150	7.52	-	-	7.77	5.99	-	-	-	-	-
11	20.23	480	5.64	-	-	8.39	6.02	-	-	-	-	-
12	18.32	360	5.02	-	-	8.25	6.11	-	-	-	-	-
13	12.72	540	1.58	-	-	7.47	6.14	-	-	-	-	-
14	14.68	210	6.06	2.12	3.90	-	-	7.17	6.04	6.91	6.01	-
15	12.70	450	2.27	0.74	1.46	-	-	6.81	6.12	6.80	6.09	-
16	11.14	390	2.83	0.78	2.02	-	-	-	-	-	-	4
17	9.96	150	5.24	1.61	3.55	-	-	-	-	-	-	1
18	13.75	240	4.59	1.20	3.39	-	-	-	-	-	-	2
19	12.18	330	2.81	1.04	1.80	-	-	7.05	6.04	6.76	6.02	-
20	12.09	480	3.47	0.63	2.81	-	-	6.65	6.04	7.07	6.05	-
21	13.87	510	2.63	0.96	1.66	-	-	6.93	6.02	6.72	5.97	-
22	9.48	180	2.89	-	-	7.26	6.10	-	-	-	-	-
23	10.60	300	3.46	-	-	7.06	6.04	-	-	-	-	-
24	15.25	570	2.18	-	-	7.78	6.04	-	-	-	-	-

Appendix A.22 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	11.97	450	2.40	-	-	7.48	6.07	-	-	-	-	-
26	12.98	300	3.46	0.97	2.47	-	-	-	-	-	-	3
27	10.14	510	2.18	0.84	1.37	-	-	-	-	-	-	9
28	19.38	360	4.78	1.23	3.50	-	-	-	-	-	-	3
29	12.67	150	6.18	2.96	3.29	-	-	6.96	6.11	6.70	5.94	-
30	12.98	330	4.23	2.08	2.12	-	-	-	-	-	-	3
31	13.18	390	2.85	0.85	1.97	-	-	6.96	6.14	6.98	6.08	-
32	11.30	270	3.83	0.84	2.97	-	-	-	-	-	-	3
33	9.05	210	3.14	0.94	2.17	-	-	-	-	-	-	2
34	12.15	600	3.13	1.24	1.92	-	-	6.85	6.13	6.65	6.09	-
35	25.24	570	5.35	1.86	3.47	-	-	-	-	-	-	9
36	19.04	420	5.38	1.77	3.63	-	-	7.30	6.07	7.18	6.11	-
37	15.71	420	4.48	1.01	3.46	-	-	-	-	-	-	5
38	18.66	330	6.13	-	-	7.94	6.04	-	-	-	-	-
39	16.23	480	4.31	1.44	3.10	-	-	-	-	-	-	4
40	18.91	510	4.89	-	-	7.96	6.02	-	-	-	-	-
41	14.52	180	7.23	1.84	5.33	-	-	-	-	-	-	2
42	17.99	450	4.12	1.42	2.68	-	-	-	-	-	-	4
43	22.97	600	4.21	1.54	2.63	-	-	-	-	-	-	9
44	10.33	210	4.27	-	-	7.46	6.16	-	-	-	-	-
45	22.36	540	3.74	1.37	2.36	-	-	-	-	-	-	9
46	11.97	240	3.99	-	-	7.85	6.08	-	-	-	-	-
47	15.02	360	3.59	1.72	1.84	-	-	7.14	6.05	6.86	6.18	-
48	14.92	270	4.88	-	-	8.26	6.02	-	-	-	-	-

Appendix A.23

Replication 2 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.28 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 76% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
49	14.01	330	4.59	1.08	3.44	-	-	7.01	6.13	7.15	6.13	-
50	12.71	270	3.44	1.01	2.43	-	-	6.97	6.04	6.81	5.91	-
51	26.51	570	5.63	2.83	2.80	-	-	7.84	5.96	6.89	6.00	-
52	10.81	300	3.09	-	-	7.59	6.12	-	-	-	-	-
53	12.61	150	6.64	2.05	4.58	-	-	6.90	6.13	6.92	6.13	-
54	12.09	600	2.56	0.87	1.63	-	-	6.82	5.99	6.94	6.04	-
55	15.27	420	3.04	-	-	8.27	6.18	-	-	-	-	-
56	11.37	210	4.10	-	-	7.50	6.00	-	-	-	-	-
57	12.53	240	3.89	1.13	2.71	-	-	-	-	-	-	3
58	9.86	480	2.13	0.70	1.34	-	-	6.76	6.08	6.65	5.99	-
59	12.22	450	2.37	-	-	7.75	6.10	-	-	-	-	-
60	10.00	540	1.95	-	-	7.36	5.97	-	-	-	-	-
61	11.30	450	1.84	0.65	1.20	-	-	6.64	6.07	6.93	6.19	-
62	11.40	330	2.72	0.78	1.92	-	-	-	-	-	-	3
63	20.03	270	5.47	-	-	8.25	5.99	-	-	-	-	-
64	14.55	510	2.13	-	-	7.63	6.00	-	-	-	-	-
65	12.30	540	2.54	1.01	1.51	-	-	-	-	-	-	9
66	10.32	390	2.11	0.78	1.37	-	-	6.66	6.02	6.73	6.15	-
67	10.20	210	4.47	0.66	3.74	-	-	6.70	6.10	6.94	6.01	-
68	11.45	240	4.16	0.90	3.18	-	-	6.80	6.13	6.83	6.09	-
69	10.92	480	2.35	-	-	7.64	6.07	-	-	-	-	-
70	10.96	180	4.59	0.90	3.56	-	-	-	-	-	-	2
71	13.32	570	1.80	1.07	0.74	-	-	-	-	-	-	9
72	12.14	360	2.95	0.80	2.14	-	-	-	-	-	-	4

Appendix A.23 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	9.15	210	2.25	0.53	1.62	-	-	-	-	-	-	2
74	11.74	570	1.44	-	-	7.33	5.97	-	-	-	-	-
75	9.78	450	1.54	0.73	0.79	-	-	-	-	-	-	4
76	10.16	150	3.65	1.02	2.51	-	-	-	-	-	-	2
77	12.26	180	2.65	0.71	1.93	-	-	6.75	6.09	6.61	6.03	-
78	14.00	270	3.86	1.30	2.55	-	-	-	-	-	-	3
79	15.55	360	3.80	1.38	2.44	-	-	7.10	5.97	6.90	6.12	-
80	14.63	510	2.35	1.09	1.19	-	-	-	-	-	-	9
81	16.49	390	3.81	1.39	2.45	-	-	-	-	-	-	4
82	16.48	420	3.43	1.21	2.19	-	-	7.22	6.12	6.98	6.12	-
83	12.88	300	2.84	0.93	1.91	-	-	6.89	5.94	6.81	6.09	-
84	11.41	600	1.65	0.95	0.72	-	-	-	-	-	-	9
85	8.03	540	1.13	0.50	0.62	-	-	6.53	5.99	6.44	6.03	-
86	14.16	420	2.57	1.06	1.53	-	-	-	-	-	-	9
87	13.43	510	1.88	0.94	0.88	-	-	6.97	6.00	6.97	6.10	-
88	13.68	360	2.41	-	-	7.98	6.04	-	-	-	-	-
89	13.46	240	4.92	-	-	7.93	6.01	-	-	-	-	-
90	12.77	150	6.33	-	-	7.76	6.12	-	-	-	-	-
91	12.17	480	2.14	0.83	1.34	-	-	-	-	-	-	4
92	16.52	390	4.14	-	-	8.24	6.09	-	-	-	-	-
93	9.67	300	2.23	0.78	1.44	-	-	-	-	-	-	4
94	9.60	600	1.48	-	-	7.41	6.03	-	-	-	-	-
95	11.39	330	3.59	-	-	7.65	6.15	-	-	-	-	-
96	13.43	180	4.50	-	-	7.83	6.15	-	-	-	-	-

Appendix A.24

Replication 3 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 76% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
97	13.06	240	4.17	0.71	3.43	-	-	-	-	-	-	2
98	10.57	180	3.96	0.71	3.06	-	-	6.79	6.05	6.93	6.10	-
99	13.99	270	3.58	-	-	8.04	6.11	-	-	-	-	-
100	15.78	420	2.68	1.01	1.67	-	-	6.94	6.05	6.82	6.14	-
101	11.89	390	3.78	0.99	2.78	-	-	6.91	6.14	6.98	6.07	-
102	13.72	450	3.66	-	-	7.70	6.05	-	-	-	-	-
103	10.94	330	3.63	0.78	2.90	-	-	-	-	-	-	3
104	11.38	510	4.14	1.12	2.97	-	-	-	-	-	-	4
105	15.17	300	7.02	-	-	8.00	6.09	-	-	-	-	-
106	10.26	150	5.71	-	-	7.28	5.97	-	-	-	-	-
107	12.64	600	2.79	0.85	1.91	-	-	-	-	-	-	9
108	14.87	540	3.68	1.14	2.48	-	-	-	-	-	-	4
109	19.98	480	3.49	1.49	2.07	-	-	7.41	6.11	7.40	6.09	-
110	12.79	390	3.31	0.72	2.57	-	-	-	-	-	-	2
111	10.43	570	1.83	0.76	1.03	-	-	-	-	-	-	9
112	12.71	330	4.41	-	-	8.00	6.09	-	-	-	-	-
113	10.31	270	4.64	1.85	2.68	-	-	6.95	6.09	6.75	6.07	-
114	10.48	150	5.66	2.72	2.92	-	-	-	-	-	-	2
115	10.56	360	3.37	0.56	2.73	-	-	-	-	-	-	3
116	13.26	540	3.43	0.94	2.40	-	-	6.93	6.02	7.00	6.08	-
117	8.85	240	3.41	0.75	2.65	-	-	6.64	6.06	6.65	6.04	-
118	8.05	210	3.61	1.02	2.61	-	-	6.57	6.05	6.62	6.13	-
119	10.48	510	2.88	-	-	7.34	5.98	-	-	-	-	-
120	12.88	420	3.57	1.09	2.38	-	-	-	-	-	-	3

Appendix A.24 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
121	12.85	480	3.21	-	-	7.72	6.11	-	-	-	-	-
122	15.54	330	5.61	2.53	2.98	-	-	7.32	6.11	6.85	6.09	-
123	11.26	360	3.94	1.47	2.44	-	-	6.99	6.14	6.83	6.11	-
124	11.47	240	4.68	-	-	7.35	6.04	-	-	-	-	-
125	9.58	300	4.36	0.84	3.49	-	-	-	-	-	-	3
126	13.20	570	3.56	-	-	7.71	6.15	-	-	-	-	-
127	9.83	210	4.99	-	-	7.52	6.19	-	-	-	-	-
128	12.83	390	4.73	-	-	7.81	6.10	-	-	-	-	-
129	9.23	180	4.00	0.65	3.34	-	-	-	-	-	-	2
130	10.24	600	1.93	-	-	7.24	5.97	-	-	-	-	-
131	11.43	450	3.17	0.76	2.39	-	-	6.72	6.05	6.84	6.08	-
132	12.18	510	2.41	0.80	1.65	-	-	6.86	6.10	6.90	6.10	-
133	8.10	480	2.14	0.58	1.52	-	-	-	-	-	-	4
134	9.77	360	2.82	-	-	7.26	6.06	-	-	-	-	-
135	11.36	270	3.89	1.44	2.49	-	-	-	-	-	-	2
136	13.32	150	5.14	1.79	3.33	-	-	6.97	6.11	6.75	6.08	-
137	18.21	300	7.57	3.00	4.51	-	-	7.37	6.08	7.00	6.01	-
138	14.60	420	4.81	-	-	7.85	6.05	-	-	-	-	-
139	8.61	450	2.13	0.42	1.59	-	-	-	-	-	-	4
140	9.81	540	2.92	-	-	7.50	6.17	-	-	-	-	-
141	9.39	210	4.68	1.61	3.07	-	-	-	-	-	-	2
142	14.75	570	3.40	1.29	2.10	-	-	7.07	6.12	6.78	5.97	-
143	10.16	180	5.84	-	-	7.47	6.14	-	-	-	-	-
144	10.24	600	2.02	0.64	1.34	-	-	6.71	6.12	6.64	6.01	-

Appendix A.25

Replication 1 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 76% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
1	12.22	390	3.03	0.91	2.13	-	-	6.94	6.01	6.99	6.10	-
2	12.74	600	2.33	0.98	1.31	-	-	7.03	6.09	6.75	6.02	-
3	16.38	540	2.91	-	-	8.20	6.06	-	-	-	-	-
4	10.53	420	2.44	0.78	1.66	-	-	-	-	-	-	3
5	15.94	240	6.95	-	-	8.00	6.08	-	-	-	-	-
6	8.92	600	2.04	0.51	1.45	-	-	-	-	-	-	9
7	18.23	270	5.78	-	-	8.31	5.94	-	-	-	-	-
8	13.53	510	2.05	1.03	1.02	-	-	-	-	-	-	4
9	12.51	360	3.38	-	-	7.60	6.14	-	-	-	-	-
10	11.65	480	1.93	1.00	0.93	-	-	-	-	-	-	4
11	14.93	450	2.81	1.00	1.72	-	-	-	-	-	-	4
12	14.64	300	4.28	-	-	7.99	5.93	-	-	-	-	-
13	13.39	330	3.71	0.97	2.72	-	-	6.98	6.07	7.22	6.02	-
14	14.18	480	2.82	-	-	7.77	6.11	-	-	-	-	-
15	14.27	540	3.27	1.39	1.86	-	-	-	-	-	-	4
16	13.02	540	2.60	0.77	1.82	-	-	6.81	6.08	6.69	5.98	-
17	14.22	150	7.93	-	-	7.92	6.06	-	-	-	-	-
18	17.36	180	8.39	3.65	4.64	-	-	7.21	6.07	6.94	6.05	-
19	11.75	570	2.20	0.82	1.32	-	-	-	-	-	-	9
20	11.65	210	5.15	1.73	3.33	-	-	-	-	-	-	3
21	12.27	300	4.35	1.29	2.93	-	-	-	-	-	-	3
22	12.91	570	2.98	0.92	2.02	-	-	6.99	6.06	7.01	6.08	-
23	13.69	270	3.81	1.01	2.72	-	-	7.06	6.14	6.86	6.02	-
24	12.81	390	2.97	0.94	1.93	-	-	-	-	-	-	3

Appendix A.25 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	10.51	240	3.24	0.84	2.36	-	-	6.74	5.96	6.71	6.02	-
26	15.25	180	5.73	-	-	7.99	6.14	-	-	-	-	-
27	14.63	450	2.19	-	-	7.92	6.10	-	-	-	-	-
28	12.58	390	2.32	-	-	7.67	6.14	-	-	-	-	-
29	10.38	330	2.68	-	-	7.46	6.06	-	-	-	-	-
30	11.87	360	3.58	1.01	2.58	-	-	6.98	6.18	6.86	6.03	-
31	12.40	210	4.64	1.31	3.33	-	-	6.81	5.94	6.77	6.04	-
32	13.40	270	4.00	1.18	2.79	-	-	-	-	-	-	3
33	10.10	480	1.77	0.66	1.16	-	-	6.70	6.07	6.70	6.21	-
34	10.73	510	2.56	0.80	1.77	-	-	6.90	6.11	6.86	6.06	-
35	11.30	420	3.10	-	-	7.73	6.08	-	-	-	-	-
36	13.10	150	6.35	3.08	3.26	-	-	7.12	6.06	6.93	6.19	-
37	16.19	180	7.67	2.70	4.97	-	-	-	-	-	-	2
38	13.33	450	2.80	0.77	2.01	-	-	6.78	6.00	6.82	6.10	-
39	13.06	330	2.89	0.94	1.89	-	-	-	-	-	-	3
40	9.05	600	1.45	-	-	7.43	6.06	-	-	-	-	-
41	14.57	150	7.32	3.06	4.15	-	-	-	-	-	-	2
42	12.13	360	3.50	0.85	2.61	-	-	-	-	-	-	3
43	10.17	420	2.02	0.81	1.23	-	-	6.84	6.13	6.66	6.11	-
44	13.74	300	3.19	0.73	2.21	-	-	6.87	5.99	6.88	6.01	-
45	16.48	210	6.41	-	-	7.90	6.13	-	-	-	-	-
46	11.05	510	1.97	-	-	7.40	5.98	-	-	-	-	-
47	12.96	240	4.47	1.35	3.06	-	-	-	-	-	-	3
48	12.61	570	1.86	-	-	7.66	6.04	-	-	-	-	-

Appendix A.26

Replication 2 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 76% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
49	15.85	390	5.00	-	-	8.55	6.05	-	-	-	-	-
50	11.95	300	2.93	-	-	7.61	6.10	-	-	-	-	-
51	7.70	600	1.18	-	-	7.16	6.05	-	-	-	-	-
52	11.54	510	1.75	0.85	0.90	-	-	-	-	-	-	4
53	11.72	450	2.65	0.84	1.84	-	-	6.87	6.07	6.74	6.02	-
54	11.91	480	1.43	0.92	0.47	-	-	-	-	-	-	4
55	14.31	270	5.08	-	-	7.88	6.08	-	-	-	-	-
56	15.78	180	7.16	-	-	7.93	6.05	-	-	-	-	-
57	15.27	210	7.16	2.94	4.11	-	-	7.14	6.11	6.86	6.03	-
58	12.36	330	3.46	1.19	2.27	-	-	-	-	-	-	3
59	14.12	150	8.11	4.85	3.21	-	-	-	-	-	-	2
60	10.78	420	1.53	0.78	0.70	-	-	-	-	-	-	3
61	12.29	510	1.69	0.96	0.73	-	-	7.02	6.06	6.75	6.07	-
62	10.66	420	1.74	-	-	7.34	6.10	-	-	-	-	-
63	10.99	540	2.37	-	-	7.74	5.92	-	-	-	-	-
64	12.22	360	2.14	0.89	1.29	-	-	6.90	6.08	6.67	6.05	-
65	11.80	150	7.06	3.91	3.12	-	-	6.86	6.08	6.51	6.08	-
66	10.50	570	2.17	0.66	1.35	-	-	6.82	6.10	6.94	6.12	-
67	8.92	600	1.40	0.79	0.59	-	-	-	-	-	-	9
68	12.87	390	3.08	0.80	2.06	-	-	6.86	6.02	6.89	6.05	-
69	15.46	240	6.49	-	-	7.86	6.13	-	-	-	-	-
70	12.63	270	4.28	1.44	2.81	-	-	7.15	6.15	6.81	6.10	-
71	10.32	450	2.65	0.91	1.76	-	-	-	-	-	-	9
72	12.39	300	3.27	0.88	2.37	-	-	6.91	6.08	7.19	6.13	-

Appendix A.26 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	9.84	480	1.18	0.70	0.45	-	-	6.80	6.16	6.46	6.03	-
74	13.32	240	3.11	1.09	1.97	-	-	7.01	5.91	6.81	5.98	-
75	12.33	480	1.96	-	-	7.84	6.17	-	-	-	-	-
76	9.07	540	1.07	0.56	0.43	-	-	-	-	-	-	9
77	17.13	180	5.86	1.76	4.08	-	-	7.18	6.05	6.73	6.02	-
78	13.89	210	4.06	1.06	2.99	-	-	-	-	-	-	3
79	8.90	360	2.04	0.70	1.36	-	-	-	-	-	-	4
80	16.03	330	3.27	-	-	7.98	6.10	-	-	-	-	-
81	11.39	300	2.90	0.79	2.04	-	-	-	-	-	-	3
82	17.50	150	8.47	-	-	8.29	6.04	-	-	-	-	-
83	8.48	570	1.67	0.65	1.02	-	-	-	-	-	-	9
84	12.81	510	1.98	-	-	7.80	6.00	-	-	-	-	-
85	11.00	450	2.41	-	-	7.57	6.05	-	-	-	-	-
86	13.65	210	5.25	-	-	7.84	6.06	-	-	-	-	-
87	10.26	600	1.53	0.75	0.71	-	-	6.73	5.96	6.62	6.01	-
88	9.64	240	2.37	0.71	1.61	-	-	-	-	-	-	3
89	9.84	540	1.76	0.53	1.13	-	-	6.68	6.02	6.66	6.01	-
90	10.43	270	3.00	1.05	1.95	-	-	-	-	-	-	3
91	10.40	390	2.08	0.76	1.29	-	-	-	-	-	-	3
92	14.82	180	7.26	3.10	4.15	-	-	-	-	-	-	3
93	11.62	360	2.64	-	-	7.61	6.15	-	-	-	-	-
94	11.13	570	1.75	-	-	7.75	6.12	-	-	-	-	-
95	9.67	420	1.75	0.64	1.13	-	-	6.70	6.08	6.59	6.08	-
96	12.33	330	2.75	0.90	1.85	-	-	6.90	6.04	6.92	6.10	-

Appendix A.27

Replication 3 data for thin-layer drying at an air temperature of 65°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 76% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
97	9.35	510	3.25	1.37	1.82	-	-	-	-	-	-	4
98	15.18	360	4.89	-	-	7.79	6.12	-	-	-	-	-
99	12.40	240	4.81	-	-	7.64	6.02	-	-	-	-	-
100	11.67	420	2.75	0.85	1.90	-	-	-	-	-	-	5
101	8.58	330	2.58	0.63	1.82	-	-	6.68	6.06	6.84	6.16	-
102	11.58	150	6.33	3.26	3.09	-	-	-	-	-	-	2
103	13.81	300	5.53	-	-	8.01	6.08	-	-	-	-	-
104	14.68	180	6.12	3.07	3.01	-	-	-	-	-	-	2
105	7.93	390	2.42	0.73	1.65	-	-	6.59	6.12	6.51	6.18	-
106	10.74	480	2.88	0.95	1.93	-	-	-	-	-	-	4
107	10.38	450	2.63	-	-	7.34	6.12	-	-	-	-	-
108	12.71	210	5.80	2.98	2.75	-	-	7.06	6.10	6.77	6.11	-
109	9.66	570	2.81	-	-	7.30	6.11	-	-	-	-	-
110	10.41	600	1.70	-	-	7.35	6.05	-	-	-	-	-
111	13.28	300	4.40	1.32	3.06	-	-	6.99	6.12	6.93	6.16	-
112	10.95	450	2.06	0.95	1.16	-	-	6.97	6.08	6.89	6.16	-
113	12.65	420	3.29	-	-	7.78	6.05	-	-	-	-	-
114	13.05	240	6.26	3.65	2.67	-	-	7.15	6.04	6.92	6.09	-
115	11.53	570	2.53	0.76	1.61	-	-	6.89	6.08	6.90	6.13	-
116	11.97	360	3.17	0.94	2.21	-	-	-	-	-	-	3
117	15.40	180	8.74	5.15	3.54	-	-	7.31	6.12	7.03	6.11	-
118	10.33	540	2.11	-	-	7.29	6.00	-	-	-	-	-
119	11.11	390	2.55	-	-	7.54	6.11	-	-	-	-	-
120	14.79	270	4.61	-	-	7.78	6.06	-	-	-	-	-

Appendix A.27 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
121	9.87	450	2.50	0.47	2.00	-	-	-	-	-	-	4
122	11.43	300	3.77	1.85	1.77	-	-	-	-	-	-	4
123	14.90	150	7.84	3.16	4.65	-	-	7.10	6.11	6.86	6.10	-
124	9.86	270	2.67	0.89	1.73	-	-	6.91	5.99	6.78	6.14	-
125	10.81	420	3.05	0.99	2.06	-	-	6.86	6.06	6.70	6.07	-
126	10.69	540	2.98	0.87	2.09	-	-	-	-	-	-	9
127	9.67	510	2.39	1.03	1.36	-	-	6.83	6.09	6.60	5.96	-
128	12.28	210	5.07	2.38	2.67	-	-	-	-	-	-	3
129	12.17	390	2.92	1.27	1.56	-	-	-	-	-	-	3
130	11.93	480	3.67	-	-	7.90	6.10	-	-	-	-	-
131	8.71	360	3.21	0.83	2.31	-	-	6.60	6.05	6.60	6.09	-
132	11.09	330	3.43	0.96	2.45	-	-	-	-	-	-	3
133	9.35	570	1.22	0.61	0.45	-	-	-	-	-	-	9
134	11.50	240	4.59	1.78	2.74	-	-	-	-	-	-	3
135	11.28	600	2.61	0.92	1.73	-	-	-	-	-	-	9
136	17.53	210	9.30	-	-	8.24	6.07	-	-	-	-	-
137	13.36	510	3.04	-	-	7.90	6.09	-	-	-	-	-
138	12.73	150	9.09	-	-	7.55	6.01	-	-	-	-	-
139	14.53	180	9.65	-	-	7.83	6.17	-	-	-	-	-
140	10.65	270	4.55	2.23	2.27	-	-	-	-	-	-	3
141	13.56	600	3.92	1.17	2.72	-	-	6.98	6.11	6.84	6.04	-
142	13.37	540	2.65	0.80	1.82	-	-	6.89	6.11	6.72	6.11	-
143	10.60	330	3.75	-	-	7.74	6.15	-	-	-	-	-
144	10.75	480	2.30	0.92	1.32	-	-	6.93	6.18	6.60	6.05	-

Appendix A.28

Replication 1 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 69% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
1	16.01	480	3.40	-	-	8.23	6.16	-	-	-	-	-
2	15.60	420	3.59	-	-	7.71	5.97	-	-	-	-	-
3	10.94	270	3.41	0.91	2.47	-	-	6.89	6.12	6.84	6.16	-
4	14.55	510	2.43	-	-	7.73	6.07	-	-	-	-	-
5	11.28	300	3.32	-	-	7.37	6.03	-	-	-	-	-
6	14.77	120	9.15	4.22	4.88	-	-	-	-	-	-	2
7	16.36	210	7.61	2.99	4.62	-	-	7.18	6.13	6.82	6.11	-
8	10.86	540	1.55	-	-	7.42	6.03	-	-	-	-	-
9	18.38	360	4.87	-	-	8.45	6.06	-	-	-	-	-
10	17.38	390	4.09	-	-	8.22	6.08	-	-	-	-	-
11	12.34	450	2.34	-	-	7.87	6.09	-	-	-	-	-
12	9.08	240	2.13	0.77	1.40	-	-	-	-	-	-	3
13	16.45	540	2.68	1.01	1.57	-	-	7.10	6.01	7.04	6.09	-
14	14.75	150	8.38	4.65	3.60	-	-	7.27	6.07	6.88	6.08	-
15	18.85	180	8.92	-	-	8.08	6.00	-	-	-	-	-
16	20.79	450	5.01	1.84	3.11	-	-	7.67	6.13	7.17	6.05	-
17	17.10	210	5.41	1.36	4.08	-	-	-	-	-	-	3
18	10.30	570	1.57	-	-	7.35	6.11	-	-	-	-	-
19	13.08	120	7.94	-	-	7.83	6.13	-	-	-	-	-
20	14.47	420	3.78	1.63	2.18	-	-	7.24	6.15	6.94	6.20	-
21	14.02	330	2.80	-	-	7.94	6.07	-	-	-	-	-
22	10.76	240	3.18	0.80	2.29	-	-	6.90	6.14	6.73	6.04	-
23	15.29	270	5.47	2.11	3.27	-	-	-	-	-	-	5
24	27.47	480	5.88	2.39	3.43	-	-	8.03	6.01	7.32	6.12	-

Appendix A.28 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	9.73	330	3.13	0.77	2.35	-	-	-	-	-	-	3
26	17.29	360	4.79	1.74	3.12	-	-	7.37	6.15	6.87	6.08	-
27	15.39	420	3.72	1.74	2.01	-	-	-	-	-	-	3
28	12.92	510	1.96	1.05	0.85	-	-	7.13	6.13	6.81	6.05	-
29	12.12	180	6.17	2.74	3.43	-	-	7.11	6.16	6.78	6.14	-
30	15.95	390	4.57	1.68	2.80	-	-	7.13	6.07	6.84	6.10	-
31	10.28	120	4.62	1.51	3.09	-	-	6.68	6.01	6.62	6.11	-
32	13.16	570	2.05	0.97	1.02	-	-	6.94	5.99	6.90	6.12	-
33	8.86	540	1.65	0.70	0.97	-	-	-	-	-	-	9
34	15.66	150	8.57	4.42	4.03	-	-	-	-	-	-	2
35	10.45	300	3.51	1.27	2.22	-	-	-	-	-	-	3
36	12.38	240	3.24	-	-	7.75	6.11	-	-	-	-	-
37	9.40	570	1.31	0.63	0.57	-	-	-	-	-	-	9
38	17.05	330	3.58	1.26	2.33	-	-	7.34	6.18	7.11	6.13	-
39	13.51	270	3.73	-	-	7.44	6.05	-	-	-	-	-
40	14.05	480	2.95	0.98	1.90	-	-	-	-	-	-	4
41	13.55	210	5.16	-	-	7.81	6.08	-	-	-	-	-
42	11.23	180	5.14	1.96	3.09	-	-	-	-	-	-	3
43	10.20	300	3.22	0.96	2.15	-	-	6.88	6.05	6.65	6.03	-
44	11.81	510	1.75	0.93	0.79	-	-	-	-	-	-	9
45	17.03	360	5.30	2.31	2.97	-	-	-	-	-	-	3
46	14.88	150	8.41	-	-	8.17	6.13	-	-	-	-	-
47	10.61	390	2.69	0.85	1.79	-	-	-	-	-	-	3
48	12.47	450	2.68	0.82	1.88	-	-	-	-	-	-	7

Appendix A.29

Replication 2 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.23 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 69% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
49	18.32	480	2.69	-	-	8.40	6.07	-	-	-	-	-
50	14.13	210	3.88	1.03	2.77	-	-	6.99	6.05	6.95	6.04	-
51	12.17	450	1.40	-	-	7.32	6.09	-	-	-	-	-
52	14.13	390	2.00	-	-	7.57	6.12	-	-	-	-	-
53	15.15	240	4.18	1.28	2.89	-	-	-	-	-	-	3
54	15.17	540	3.00	-	-	8.12	6.13	-	-	-	-	-
55	10.28	120	4.32	1.24	3.03	-	-	6.78	6.12	6.61	5.98	-
56	13.60	420	1.72	-	-	7.55	6.03	-	-	-	-	-
57	14.70	300	3.31	1.07	2.13	-	-	7.05	6.09	6.82	6.09	-
58	7.92	570	1.13	-	-	7.13	6.11	-	-	-	-	-
59	13.81	270	3.86	1.41	2.32	-	-	7.09	6.03	6.88	6.04	-
60	15.27	360	2.69	1.10	1.60	-	-	7.09	6.03	6.93	6.05	-
61	12.20	420	2.51	0.79	1.70	-	-	6.79	5.99	6.88	6.09	-
62	14.10	330	2.90	-	-	7.51	6.03	-	-	-	-	-
63	13.27	450	2.56	1.02	1.54	-	-	7.04	6.10	6.66	5.94	-
64	16.65	510	3.41	-	-	8.04	6.03	-	-	-	-	-
65	15.50	240	4.31	-	-	8.00	6.07	-	-	-	-	-
66	16.19	120	10.38	-	-	8.12	6.22	-	-	-	-	-
67	14.58	150	8.67	-	-	7.98	6.20	-	-	-	-	-
68	13.26	180	6.48	-	-	7.64	6.13	-	-	-	-	-
69	13.00	360	2.34	-	-	7.67	6.18	-	-	-	-	-
70	16.04	210	5.22	1.48	3.66	-	-	-	-	-	-	3
71	16.77	480	3.51	1.59	1.90	-	-	7.50	6.13	6.86	6.16	-
72	10.59	540	1.63	0.95	0.58	-	-	6.92	6.03	6.64	6.08	-

Appendix A.29 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	15.99	420	2.25	1.07	1.11	-	-	-	-	-	-	4
74	14.96	300	2.83	-	-	7.81	6.10	-	-	-	-	-
75	18.88	120	7.41	2.22	5.22	-	-	-	-	-	-	3
76	11.06	540	1.44	0.80	0.61	-	-	-	-	-	-	9
77	13.04	270	4.01	-	-	8.02	6.05	-	-	-	-	-
78	13.15	180	5.09	1.98	3.09	-	-	7.27	6.13	6.73	6.02	-
79	19.14	330	4.51	1.62	2.81	-	-	7.59	6.14	7.02	6.04	-
80	10.90	570	1.36	0.75	0.56	-	-	6.87	6.12	6.59	6.08	-
81	12.62	390	2.38	0.89	1.51	-	-	6.87	6.00	6.88	6.12	-
82	13.11	150	6.07	3.07	2.92	-	-	-	-	-	-	3
83	12.08	240	4.27	1.78	2.41	-	-	6.81	6.04	6.55	6.04	-
84	15.44	510	2.69	1.03	1.68	-	-	7.03	6.05	6.97	5.98	-
85	10.28	510	1.55	0.81	0.68	-	-	-	-	-	-	9
86	10.81	390	1.47	0.74	0.66	-	-	-	-	-	-	4
87	13.54	330	2.69	0.95	1.76	-	-	-	-	-	-	3
88	18.32	450	2.55	1.18	1.30	-	-	-	-	-	-	4
89	20.87	360	3.65	1.46	2.14	-	-	-	-	-	-	4
90	12.08	180	3.90	1.51	2.54	-	-	-	-	-	-	3
91	11.91	570	1.86	0.74	1.09	-	-	-	-	-	-	9
92	16.56	150	7.46	3.05	4.30	-	-	7.24	6.05	6.91	5.98	-
93	15.52	480	2.26	1.27	0.99	-	-	-	-	-	-	9
94	13.98	210	3.85	-	-	7.92	6.19	-	-	-	-	-
95	11.99	270	3.62	1.47	2.12	-	-	-	-	-	-	3
96	14.46	300	3.67	1.02	2.60	-	-	-	-	-	-	3

Appendix A.30

Replication 3 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.23 m³/sec·m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 69% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
97	14.57	240	4.38	1.16	3.23	-	-	6.94	6.05	6.80	6.14	-
98	14.78	420	3.48	-	-	7.63	5.98	-	-	-	-	-
99	10.74	540	1.75	-	-	7.54	6.17	-	-	-	-	-
100	13.34	360	3.56	-	-	7.57	6.05	-	-	-	-	-
101	12.50	390	2.84	-	-	7.63	6.09	-	-	-	-	-
102	13.77	270	5.75	1.99	3.64	-	-	7.13	6.18	6.75	6.06	-
103	12.30	120	7.19	3.19	3.95	-	-	7.10	6.18	6.85	5.99	-
104	14.24	300	4.63	1.53	3.08	-	-	7.13	6.01	6.82	5.95	-
105	18.52	450	4.46	-	-	8.20	6.14	-	-	-	-	-
106	14.96	210	4.73	-	-	8.05	6.12	-	-	-	-	-
107	15.83	480	4.22	-	-	8.29	6.06	-	-	-	-	-
108	14.18	510	2.50	-	-	7.80	6.00	-	-	-	-	-
109	13.28	360	3.66	0.87	2.70	-	-	6.93	6.09	7.03	6.15	-
110	10.39	210	4.10	0.99	3.09	-	-	6.83	6.06	6.71	6.05	-
111	14.16	240	5.45	-	-	7.78	6.04	-	-	-	-	-
112	12.63	510	2.60	0.95	1.62	-	-	7.03	6.13	6.85	6.04	-
113	14.42	330	4.29	1.27	2.93	-	-	7.09	6.07	6.95	6.04	-
114	11.93	390	4.25	1.14	3.15	-	-	6.93	6.15	6.98	6.13	-
115	19.31	150	11.67	-	-	8.52	6.09	-	-	-	-	-
116	13.74	480	3.45	1.51	1.88	-	-	7.60	6.18	7.03	6.09	-
117	17.31	450	3.74	1.39	2.25	-	-	7.39	6.06	7.00	6.11	-
118	12.99	420	3.59	1.12	2.45	-	-	6.83	6.09	6.86	6.12	-
119	10.73	180	4.34	1.30	3.04	-	-	-	-	-	-	3
120	9.01	540	1.35	0.54	0.75	-	-	6.68	6.12	6.61	6.03	-

Appendix A.30 (continued)

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
121	8.80	570	1.35	-	-	7.34	6.18	-	-	-	-	-
122	15.81	180	6.40	2.76	3.60	-	-	7.32	6.18	6.94	6.18	-
123	12.86	330	4.16	-	-	7.71	6.08	-	-	-	-	-
124	15.01	390	3.92	1.27	2.65	-	-	-	-	-	-	4
125	14.87	150	8.27	3.52	4.63	-	-	-	-	-	-	3
126	11.27	120	6.60	3.10	3.44	-	-	-	-	-	-	2
127	10.20	450	2.05	0.49	1.46	-	-	-	-	-	-	4
128	16.79	270	4.58	-	-	8.40	6.12	-	-	-	-	-
129	10.06	210	4.47	1.39	3.08	-	-	-	-	-	-	3
130	18.77	510	3.98	1.29	2.67	-	-	-	-	-	-	9
131	10.71	540	2.87	0.76	2.00	-	-	-	-	-	-	9
132	14.75	300	3.83	1.27	2.59	-	-	-	-	-	-	3
133	12.24	420	2.55	1.10	1.45	-	-	-	-	-	-	4
134	8.01	570	1.63	0.80	0.79	-	-	6.72	6.09	6.48	6.11	-
135	11.96	480	2.79	1.12	1.53	-	-	-	-	-	-	4
136	11.97	300	3.46	-	-	7.73	6.08	-	-	-	-	-
137	9.09	570	1.94	0.64	1.27	-	-	-	-	-	-	9
138	12.62	150	8.78	4.99	3.72	-	-	6.98	6.11	6.69	6.18	-
139	11.52	240	5.19	2.74	2.42	-	-	-	-	-	-	3
140	12.45	120	6.84	-	-	7.54	6.06	-	-	-	-	-
141	13.36	180	4.02	-	-	7.88	6.09	-	-	-	-	-
142	13.80	330	2.82	1.02	1.79	-	-	-	-	-	-	4
143	11.40	360	3.09	0.69	2.30	-	-	-	-	-	-	4
144	9.62	270	2.91	0.76	2.04	-	-	-	-	-	-	5

Appendix A.31

Replication 1 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.28 m³/secm². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 77% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
1	17.53	210	4.24	1.43	2.81	-	-	7.28	6.00	7.00	6.11	-
2	16.93	360	3.10	1.33	1.72	-	-	-	-	-	-	3
3	13.28	120	5.07	1.37	3.72	-	-	6.85	6.04	6.73	6.11	-
4	22.86	450	4.21	-	-	8.94	6.11	-	-	-	-	-
5	14.30	150	5.94	1.92	3.96	-	-	-	-	-	-	2
6	13.71	540	2.53	0.94	1.54	-	-	-	-	-	-	9
7	21.25	330	4.90	1.61	3.23	-	-	7.59	6.17	7.25	6.14	-
8	15.27	240	4.92	1.03	3.88	-	-	-	-	-	-	3
9	18.25	570	2.98	-	-	8.49	6.03	-	-	-	-	-
10	12.89	270	3.16	0.93	2.17	-	-	7.08	6.11	6.92	6.13	-
11	12.82	180	3.76	0.89	2.89	-	-	-	-	-	-	2
12	18.84	390	3.05	-	-	8.17	6.06	-	-	-	-	-
13	22.45	300	5.28	1.85	2.45	-	-	7.53	6.08	7.02	6.09	-
14	12.42	480	2.37	0.78	1.55	-	-	-	-	-	-	9
15	16.36	570	2.18	1.08	1.07	-	-	-	-	-	-	9
16	11.20	300	2.12	0.73	1.44	-	-	-	-	-	-	3
17	22.19	270	6.34	2.17	4.10	-	-	-	-	-	-	3
18	13.76	150	5.86	-	-	7.69	5.99	-	-	-	-	-
19	15.45	510	2.20	1.18	1.15	-	-	7.05	5.95	6.84	5.98	-
20	16.14	180	5.24	-	-	7.97	6.05	-	-	-	-	-
21	19.54	480	3.47	-	-	8.25	6.23	-	-	-	-	-
22	14.90	330	3.18	1.06	2.08	-	-	-	-	-	-	3
23	11.77	390	3.03	0.75	2.32	-	-	6.62	5.99	6.72	6.03	-
24	27.73	420	7.05	-	-	9.19	6.11	-	-	-	-	-

Appendix A.31 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	18.03	420	3.07	1.12	1.83	-	-	-	-	-	-	5
26	24.08	300	5.75	-	-	8.60	6.09	-	-	-	-	-
27	13.62	540	1.67	0.95	0.78	-	-	7.01	6.11	6.85	6.14	-
28	13.84	510	2.28	-	-	7.81	6.11	-	-	-	-	-
29	14.90	450	2.83	0.90	1.87	-	-	6.98	6.14	6.83	5.98	-
30	14.67	330	2.69	-	-	7.71	6.13	-	-	-	-	-
31	12.07	390	2.60	0.81	1.80	-	-	-	-	-	-	4
32	17.93	360	2.85	-	-	8.14	6.04	-	-	-	-	-
33	12.42	150	5.64	1.32	4.36	-	-	6.79	6.05	7.09	6.16	-
34	16.11	240	4.23	1.14	3.08	-	-	6.93	6.06	6.77	6.05	-
35	12.76	210	4.50	-	-	7.53	5.93	-	-	-	-	-
36	12.40	120	7.14	-	-	7.84	6.10	-	-	-	-	-
37	14.22	180	4.39	0.84	3.63	-	-	6.91	6.14	7.15	6.08	-
38	15.64	270	5.16	-	-	8.13	6.09	-	-	-	-	-
39	13.10	570	1.36	0.62	0.67	-	-	6.72	6.00	6.62	6.00	-
40	10.64	120	5.45	1.29	4.00	-	-	-	-	-	-	2
41	13.42	450	3.48	0.72	2.76	-	-	-	-	-	-	9
42	14.42	360	4.38	1.22	3.10	-	-	6.92	5.99	6.95	6.05	-
43	15.60	210	5.47	1.20	4.22	-	-	-	-	-	-	2
44	11.57	510	2.01	0.67	1.35	-	-	-	-	-	-	9
45	19.12	240	3.39	-	-	8.17	6.05	-	-	-	-	-
46	15.76	480	2.70	1.05	1.60	-	-	7.04	6.02	6.78	6.02	-
47	11.88	540	1.49	-	-	7.51	6.11	-	-	-	-	-
48	8.10	420	1.80	0.50	1.34	-	-	6.53	6.07	6.80	6.11	-

Appendix A.32

Replication 2 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 77% respectively.

Specimen Number	After Drying Period					After Oven Drying					PDE Code	
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)		Tare (grams)
49	21.07	450	3.60	-	-	8.88	6.10	-	-	-	-	-
50	17.20	270	3.09	1.14	1.96	-	-	7.07	5.98	6.91	6.04	-
51	11.73	240	3.12	0.73	2.35	-	-	6.76	6.05	6.93	6.20	-
52	13.92	510	1.87	-	-	7.93	6.14	-	-	-	-	-
53	16.36	180	5.49	-	-	7.94	6.11	-	-	-	-	-
54	10.61	390	2.12	0.82	1.33	-	-	-	-	-	-	4
55	13.42	150	4.47	1.21	3.17	-	-	7.06	6.13	6.85	6.07	-
56	19.93	330	4.13	1.52	2.54	-	-	-	-	-	-	3
57	14.95	300	2.89	1.06	1.72	-	-	-	-	-	-	3
58	16.85	480	2.19	-	-	8.03	5.99	-	-	-	-	-
59	13.43	540	1.70	0.86	0.72	-	-	6.92	6.08	6.75	6.05	-
60	14.79	420	2.94	1.00	1.95	-	-	-	-	-	-	9
61	17.00	120	4.79	1.34	3.40	-	-	7.25	6.08	7.02	6.02	-
62	15.82	150	4.85	-	-	7.77	6.06	-	-	-	-	-
63	9.65	570	1.23	-	-	7.24	6.14	-	-	-	-	-
64	12.62	510	1.84	0.94	0.79	-	-	-	-	-	-	9
65	9.87	300	2.82	-	-	7.42	6.04	-	-	-	-	-
66	18.17	330	3.06	-	-	8.53	6.09	-	-	-	-	-
67	13.25	210	3.82	0.82	2.94	-	-	-	-	-	-	3
68	25.56	390	3.79	1.86	1.95	-	-	7.82	6.08	7.05	6.02	-
69	14.53	480	2.27	1.18	1.19	-	-	7.13	6.11	7.11	6.11	-
70	10.23	240	4.87	-	-	8.44	6.10	-	-	-	-	-
71	12.69	360	2.03	-	-	7.58	6.06	-	-	-	-	-
72	12.23	450	1.75	0.92	0.82	-	-	-	-	-	-	9

Appendix A.32 (continued)

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						PDE Code
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	24.66	420	4.70	1.95	2.74	-	-	7.76	6.04	7.25	6.11	-
74	9.58	240	2.77	0.85	1.97	-	-	-	-	-	-	3
75	12.88	510	1.54	0.75	0.72	-	-	6.72	5.99	6.84	6.12	-
76	11.68	180	3.74	0.97	2.72	-	-	6.85	6.10	6.92	6.20	-
77	19.36	330	4.38	1.50	2.87	-	-	7.53	6.11	7.01	6.13	-
78	15.42	270	2.79	-	-	7.91	6.08	-	-	-	-	-
79	12.19	120	4.48	-	-	7.76	6.09	-	-	-	-	-
80	14.93	210	3.71	-	-	7.91	6.11	-	-	-	-	-
81	14.13	360	2.36	1.12	1.22	-	-	-	-	-	-	4
82	11.23	540	1.76	-	-	7.65	6.03	-	-	-	-	-
83	18.36	390	3.46	-	-	8.05	5.99	-	-	-	-	-
84	7.41	570	0.93	0.36	0.55	-	-	-	-	-	-	9
85	21.38	270	3.48	1.52	1.90	-	-	-	-	-	-	3
86	11.81	180	3.37	0.94	2.35	-	-	-	-	-	-	2
87	11.58	120	4.46	0.76	3.69	-	-	-	-	-	-	3
88	14.38	540	2.17	0.79	1.29	-	-	-	-	-	-	9
89	13.81	300	5.44	0.77	4.60	-	-	6.73	6.03	7.18	6.06	-
90	13.55	210	4.70	0.99	3.67	-	-	6.81	6.08	6.97	5.99	-
91	11.42	570	1.69	0.79	0.89	-	-	6.79	6.03	6.84	6.07	-
92	11.94	450	2.40	0.76	1.64	-	-	6.82	6.10	6.80	6.00	-
93	18.28	360	2.48	1.28	1.22	-	-	7.23	6.00	6.85	5.94	-
94	14.88	150	7.62	1.13	6.44	-	-	-	-	-	-	2
95	16.14	420	3.32	-	-	8.08	6.11	-	-	-	-	-
96	11.76	480	1.67	0.69	0.81	-	-	-	-	-	-	9

Appendix A.33

Replication 3 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.28 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 25°C and 77% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
97	17.20	390	3.09	0.93	2.09	-	-	7.00	6.12	7.15	6.11	-
98	24.13	480	4.30	-	-	3.78	6.09	-	-	-	-	-
99	10.95	540	1.39	0.73	0.67	-	-	-	-	-	-	9
100	15.66	330	3.76	1.30	2.50	-	-	7.30	6.16	7.00	5.99	-
101	19.87	360	4.76	1.53	3.19	-	-	7.49	6.06	7.23	6.14	-
102	15.07	180	5.74	2.16	3.53	-	-	7.22	6.11	6.94	5.97	-
103	12.15	570	1.84	-	-	7.56	6.00	-	-	-	-	-
104	11.32	270	3.01	0.66	2.26	-	-	-	-	-	-	3
105	14.65	210	3.41	-	-	7.64	5.97	-	-	-	-	-
106	17.70	450	3.33	1.12	2.19	-	-	7.24	6.17	7.02	6.07	-
107	14.12	150	6.30	2.12	4.08	-	-	7.05	6.13	6.96	6.04	-
108	16.07	120	7.10	-	-	8.10	6.10	-	-	-	-	-
109	29.51	450	6.58	-	-	9.32	6.15	-	-	-	-	-
110	12.97	570	2.43	0.83	1.42	-	-	6.94	6.08	6.85	6.19	-
111	19.23	510	3.61	-	-	8.52	6.15	-	-	-	-	-
112	15.39	540	3.11	-	-	7.95	6.08	-	-	-	-	-
113	14.27	330	3.02	0.97	1.99	-	-	-	-	-	-	3
114	16.38	420	3.47	1.51	2.04	-	-	7.22	6.03	6.75	6.07	-
115	15.99	270	3.98	-	-	7.91	5.96	-	-	-	-	-
116	11.16	150	4.51	1.19	3.28	-	-	-	-	-	-	2
117	14.67	210	5.60	1.71	3.85	-	-	-	-	-	-	2
118	21.54	390	3.84	1.46	2.36	-	-	-	-	-	-	4
119	13.07	240	4.08	0.95	2.96	-	-	6.93	6.04	6.95	6.10	-
120	15.79	180	6.21	2.29	3.91	-	-	7.17	6.13	6.93	6.13	-

Appendix A.33 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
121	13.80	450	2.81	1.09	1.48	-	-	-	-	-	-	9
122	11.00	540	1.81	0.71	1.08	-	-	6.75	6.09	6.73	6.08	-
123	18.34	360	4.03	1.33	2.62	-	-	-	-	-	-	4
124	16.00	510	3.81	1.23	2.48	-	-	7.09	6.04	7.17	6.02	-
125	15.01	420	4.16	1.36	2.83	-	-	-	-	-	-	9
126	11.97	480	2.82	0.71	2.05	-	-	6.71	6.03	6.92	6.14	-
127	11.95	150	4.42	-	-	7.52	5.94	-	-	-	-	-
128	16.36	210	4.54	1.57	2.99	-	-	7.04	6.03	6.76	6.06	-
129	20.10	300	6.50	-	-	8.61	6.15	-	-	-	-	-
130	12.36	120	5.02	1.85	3.12	-	-	6.97	6.08	6.70	6.05	-
131	14.24	240	4.02	1.24	2.80	-	-	-	-	-	-	3
132	12.32	270	3.04	0.82	2.16	-	-	6.78	6.07	6.83	6.13	-
133	11.55	570	1.27	0.61	0.60	-	-	-	-	-	-	9
134	17.44	300	4.96	1.23	3.68	-	-	7.15	6.07	7.20	6.08	-
135	15.86	420	2.45	-	-	7.61	6.04	-	-	-	-	-
136	12.00	240	2.60	-	-	7.33	6.04	-	-	-	-	-
137	8.04	330	2.15	-	-	7.14	6.13	-	-	-	-	-
138	12.11	180	5.64	1.41	4.16	-	-	-	-	-	-	2
139	13.60	510	3.65	0.89	2.62	-	-	-	-	-	-	9
140	9.82	120	5.99	1.24	4.71	-	-	-	-	-	-	1
141	11.75	300	4.31	0.69	3.58	-	-	-	-	-	-	2
142	18.59	390	3.75	-	-	8.31	6.15	-	-	-	-	-
143	9.51	480	2.46	0.94	1.45	-	-	-	-	-	-	9
144	9.96	360	2.40	-	-	7.33	6.22	-	-	-	-	-

Appendix A.34

Replication 1 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.33 m³/secm². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 72% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
1	13.99	330	2.98	-	-	7.65	6.06	-	-	-	-	-
2	19.04	240	5.47	-	-	8.55	6.16	-	-	-	-	-
3	15.22	450	2.99	1.05	1.92	-	-	-	-	-	-	9
4	11.45	120	4.01	-	-	7.36	5.99	-	-	-	-	-
5	11.83	270	4.14	0.95	3.16	-	-	-	-	-	-	3
6	10.32	480	1.90	0.59	1.31	-	-	6.62	6.03	6.83	6.02	-
7	13.74	180	3.64	-	-	7.76	6.00	-	-	-	-	-
8	16.30	390	3.00	1.07	1.88	-	-	7.10	6.07	7.00	6.07	-
9	12.05	150	5.86	-	-	7.86	6.15	-	-	-	-	-
10	18.06	420	3.42	-	-	8.30	6.13	-	-	-	-	-
11	15.45	360	3.04	1.04	2.00	-	-	7.02	6.04	7.12	6.24	-
12	12.05	510	1.75	0.96	0.80	-	-	6.92	6.02	6.73	5.96	-
13	13.47	390	1.91	-	-	7.93	6.20	-	-	-	-	-
14	14.23	330	2.88	1.06	1.80	-	-	-	-	-	-	3
15	12.47	300	2.85	0.84	2.00	-	-	6.93	6.12	6.88	6.05	-
16	10.15	540	1.54	0.79	0.74	-	-	-	-	-	-	9
17	11.87	210	4.29	1.12	3.16	-	-	-	-	-	-	3
18	14.66	120	5.04	2.01	3.03	-	-	7.24	6.07	6.76	6.03	-
19	11.70	450	1.74	-	-	7.43	6.12	-	-	-	-	-
20	14.48	510	2.35	-	-	7.79	6.08	-	-	-	-	-
21	12.23	180	5.61	2.03	3.56	-	-	6.94	6.03	6.72	6.16	-
22	10.24	570	1.37	0.77	0.60	-	-	-	-	-	-	9
23	12.04	150	5.99	3.13	2.85	-	-	7.03	6.10	6.62	6.09	-
24	17.56	270	6.16	-	-	8.01	6.00	-	-	-	-	-

Appendix A.34 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
25	14.16	570	2.35	-	-	7.70	6.04	-	-	-	-	-
26	13.31	240	4.25	1.14	3.07	-	-	-	-	-	-	3
27	10.41	480	1.34	0.68	0.65	-	-	-	-	-	-	9
28	15.14	210	4.51	1.20	3.31	-	-	7.01	6.04	6.72	6.08	-
29	11.40	510	2.04	0.46	1.54	-	-	-	-	-	-	9
30	12.52	270	3.72	0.86	2.86	-	-	6.89	6.04	6.84	5.97	-
31	12.90	180	4.98	1.38	3.56	-	-	-	-	-	-	3
32	13.04	540	2.06	0.85	1.20	-	-	6.93	6.10	6.92	5.98	-
33	14.05	150	6.67	2.29	4.37	-	-	-	-	-	-	3
34	17.32	300	4.26	1.07	3.13	-	-	-	-	-	-	3
35	16.30	360	2.49	-	-	7.97	6.08	-	-	-	-	-
36	13.60	390	1.98	0.94	1.01	-	-	-	-	-	-	4
37	12.63	240	3.29	0.88	2.37	-	-	6.92	6.10	6.66	6.01	-
38	17.09	480	3.00	-	-	8.24	6.05	-	-	-	-	-
39	10.04	570	1.26	0.72	0.53	-	-	6.76	6.05	6.52	6.07	-
40	10.52	540	1.26	-	-	7.29	6.12	-	-	-	-	-
41	13.03	210	4.05	-	-	7.69	6.06	-	-	-	-	-
42	13.87	330	3.45	0.99	2.46	-	-	7.03	6.09	6.76	6.09	-
43	13.03	420	2.63	0.91	1.72	-	-	7.04	6.14	6.89	6.12	-
44	14.01	120	5.98	2.34	3.63	-	-	-	-	-	-	2
45	13.93	450	2.70	1.07	1.60	-	-	7.18	6.14	6.77	5.98	-
46	12.39	420	3.15	1.08	2.06	-	-	-	-	-	-	4
47	12.91	360	2.52	0.90	1.60	-	-	-	-	-	-	3
48	15.27	300	4.68	-	-	8.09	6.00	-	-	-	-	-

Appendix A.35

Replication 2 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.33 m³/sec m². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 72% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying						
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	PDE Code
49	11.28	510	1.56	0.67	0.87	-	-	-	-	-	-	9
50	11.72	480	1.56	0.89	0.63	-	-	-	-	-	-	9
51	13.69	270	3.65	1.02	2.61	-	-	6.91	6.02	6.58	5.99	-
52	11.88	570	1.27	0.70	0.57	-	-	-	-	-	-	9
53	11.86	150	4.35	-	-	7.48	6.03	-	-	-	-	-
54	13.73	420	2.00	0.92	1.08	-	-	6.99	6.15	6.82	6.02	-
55	13.62	360	2.05	1.06	0.95	-	-	-	-	-	-	3
56	13.69	300	3.84	0.74	3.09	-	-	6.81	6.09	7.13	6.16	-
57	13.64	180	4.11	-	-	7.53	5.92	-	-	-	-	-
58	11.40	390	1.37	0.70	0.67	-	-	-	-	-	-	3
59	12.47	510	1.62	-	-	7.52	6.01	-	-	-	-	-
60	13.18	240	2.92	0.86	2.06	-	-	6.94	6.11	7.05	6.07	-
61	13.17	570	1.75	1.04	0.70	-	-	7.02	6.09	6.72	6.05	-
62	15.01	420	2.28	1.14	1.09	-	-	-	-	-	-	4
63	10.41	390	1.21	0.67	0.54	-	-	6.71	6.05	6.61	6.15	-
64	14.78	300	2.90	-	-	8.19	5.96	-	-	-	-	-
65	11.61	210	3.76	1.02	2.71	-	-	-	-	-	-	3
66	14.97	150	6.13	1.93	4.18	-	-	7.12	5.95	6.93	6.08	-
67	12.90	450	1.65	0.84	0.79	-	-	6.82	6.01	6.61	6.00	-
68	11.24	540	1.75	-	-	7.67	6.09	-	-	-	-	-
69	12.12	330	2.19	0.81	1.38	-	-	-	-	-	-	3
70	10.80	540	1.30	0.79	0.50	-	-	6.86	6.08	6.56	6.11	-
71	12.91	120	4.82	-	-	7.59	6.06	-	-	-	-	-
72	15.84	270	3.69	1.11	2.56	-	-	-	-	-	-	3

Appendix A.35 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
73	10.76	390	2.07	-	-	7.46	6.01	-	-	-	-	-
74	14.53	210	6.61	1.97	4.63	-	-	7.00	5.98	7.00	6.01	-
75	10.62	570	1.34	-	-	7.44	6.14	-	-	-	-	-
76	14.09	180	5.35	1.66	3.67	-	-	7.11	6.13	6.74	6.03	-
77	15.02	360	3.54	1.16	2.37	-	-	7.09	6.08	6.77	6.06	-
78	12.21	120	4.48	1.57	2.91	-	-	6.88	6.00	6.70	6.06	-
79	10.06	240	1.87	0.81	1.06	-	-	-	-	-	-	3
80	14.61	450	2.18	-	-	7.80	6.01	-	-	-	-	-
81	12.93	540	2.08	0.97	1.11	-	-	-	-	-	-	9
82	12.94	300	2.09	0.70	1.37	-	-	-	-	-	-	3
83	14.55	420	2.00	-	-	7.97	6.16	-	-	-	-	-
84	16.82	330	2.63	1.22	1.40	-	-	7.26	6.07	7.04	6.10	-
85	16.94	330	2.80	-	-	8.03	6.05	-	-	-	-	-
86	14.95	120	6.37	3.13	3.22	-	-	-	-	-	-	2
87	14.17	210	2.98	-	-	7.57	6.00	-	-	-	-	-
88	12.55	360	1.62	-	-	7.45	6.07	-	-	-	-	-
89	11.48	180	4.13	1.38	2.73	-	-	-	-	-	-	2
90	12.68	270	3.80	-	-	7.64	6.05	-	-	-	-	-
91	11.58	240	3.01	-	-	7.48	5.95	-	-	-	-	-
92	10.57	480	1.61	0.78	0.82	-	-	6.77	6.01	6.77	6.05	-
93	8.88	450	1.66	0.62	0.95	-	-	-	-	-	-	4
94	14.16	150	4.02	1.05	2.97	-	-	-	-	-	-	3
95	8.86	510	1.21	0.75	0.46	-	-	6.79	6.09	6.52	6.13	-
96	12.36	480	1.48	-	-	7.48	6.09	-	-	-	-	-

Appendix A.36

Replication 1 data for thin-layer drying at an air temperature of 70°C and an airflow of 0.33 m³/secm². The air temperature and relative humidity corresponding to the dryer inlet conditions were 27°C and 72% respectively.

Specimen Number	Initial Weight (grams)	Time (min)	After Drying Period			After Oven Drying				PDE Code		
			Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)		Receptacle Weight (grams)	
97	11.34	180	3.42	-	-	7.44	5.91	-	-	-	-	-
98	13.60	450	2.16	1.04	1.11	-	-	-	-	-	-	9
99	15.47	210	4.55	-	-	7.89	5.98	-	-	-	-	-
100	12.06	240	3.41	0.83	2.57	-	-	6.89	6.13	6.69	6.06	-
101	11.37	540	2.45	0.74	1.67	-	-	-	-	-	-	9
102	16.74	330	6.15	-	-	8.45	6.09	-	-	-	-	-
103	13.00	480	2.65	-	-	7.61	6.06	-	-	-	-	-
104	12.16	270	4.73	1.49	3.22	-	-	6.98	6.19	6.76	6.14	-
105	15.00	120	6.39	-	-	8.04	6.12	-	-	-	-	-
106	12.27	150	4.04	-	-	7.67	6.11	-	-	-	-	-
107	11.42	390	2.61	-	-	7.65	6.10	-	-	-	-	-
108	10.01	570	1.34	0.55	0.79	-	-	6.66	6.13	6.79	6.03	-
109	12.85	240	3.31	0.91	2.38	-	-	-	-	-	-	3
110	9.67	510	1.46	0.72	0.71	-	-	6.77	6.08	6.62	6.04	-
111	13.27	480	2.39	1.07	1.28	-	-	-	-	-	-	9
112	12.13	450	2.16	-	-	7.48	6.03	-	-	-	-	-
113	10.96	330	2.58	0.72	1.84	-	-	-	-	-	-	3
114	12.02	360	2.95	0.98	1.94	-	-	6.92	6.06	6.75	6.11	-
115	11.97	180	4.80	1.71	3.03	-	-	7.07	6.08	6.83	6.11	-
116	13.11	210	4.84	1.38	3.45	-	-	7.08	6.11	6.96	6.04	-
117	12.53	150	5.87	2.47	3.39	-	-	7.16	6.14	6.75	6.00	-
118	13.05	540	2.12	0.87	1.23	-	-	6.95	6.10	6.74	6.05	-
119	13.08	120	5.78	2.02	3.76	-	-	6.84	5.98	6.67	6.08	-
120	13.93	300	3.35	-	-	7.60	5.98	-	-	-	-	-

Appendix A.36 (continued)

Specimen Number	After Drying Period					After Oven Drying						PDE Code
	Initial Weight (grams)	Time (min)	Flower Weight (grams)	Petal Weight (grams)	Receptacle Weight (grams)	Flower Weight (grams)	Tare (grams)	Petal Weight (grams)	Tare (grams)	Receptacle Weight (grams)	Tare (grams)	
121	12.91	390	2.90	0.97	1.91	-	-	-	-	-	-	3
122	14.89	420	3.57	-	-	7.82	6.02	-	-	-	-	-
123	13.04	330	3.22	0.95	2.27	-	-	6.84	5.94	6.82	5.96	-
124	12.40	120	5.91	2.65	3.26	-	-	-	-	-	-	2
125	12.71	420	3.69	1.48	2.20	-	-	7.08	6.09	6.81	6.05	-
126	12.44	300	4.21	1.45	2.74	-	-	-	-	-	-	3
127	9.84	570	1.47	0.68	0.78	-	-	-	-	-	-	9
128	10.91	210	4.11	1.39	2.68	-	-	-	-	-	-	3
129	13.93	270	5.21	-	-	7.72	6.01	-	-	-	-	-
130	13.11	150	5.38	2.39	2.95	-	-	-	-	-	-	2
131	11.64	480	1.93	0.78	1.13	-	-	6.88	6.14	6.74	6.08	-
132	12.77	510	2.88	-	-	7.72	6.06	-	-	-	-	-
133	16.55	240	4.57	-	-	8.41	6.07	-	-	-	-	-
134	15.81	180	6.37	2.46	3.89	-	-	-	-	-	-	2
135	13.93	270	3.17	1.02	2.13	-	-	-	-	-	-	3
136	9.55	450	2.02	0.64	1.38	-	-	6.73	6.11	6.69	6.00	-
137	12.85	540	2.22	-	-	7.55	6.07	-	-	-	-	-
138	11.48	510	2.50	0.88	1.58	-	-	-	-	-	-	9
139	16.50	360	4.65	1.31	3.30	-	-	-	-	-	-	3
140	12.29	360	3.51	-	-	7.71	6.14	-	-	-	-	-
141	10.50	570	2.10	-	-	7.52	6.08	-	-	-	-	-
142	12.05	300	2.60	0.91	1.68	-	-	6.83	5.96	6.85	6.04	-
143	10.88	390	2.55	0.74	1.81	-	-	6.65	6.01	6.91	6.04	-
144	13.52	420	2.98	0.86	2.12	-	-	-	-	-	-	4

Appendix B

Equilibrium moisture contents for Orange Lady marigolds at 25°C.

Specimen Number	Relative Humidity (%)	Flower	Petal	Receptacle
		Moisture Content Dry-Basis (%)	Moisture Content Dry-Basis (%)	Moisture Content Dry-Basis (%)
1	11	6.79	7.52	6.69
2	11	8.25	6.52	6.16
3	11	9.07	10.97	6.64
4	23	10.05	11.68	8.73
5	23	11.18	10.44	9.93
6	23	7.04	13.33	7.85
7	33	8.98	11.07	9.48
8	33	9.30	11.55	9.26
9	33	7.93	10.52	9.45
10	43	12.13	12.27	23.01
11	43	15.71	10.69	11.01
12	43	11.26	11.79	11.43
13	52	11.96	13.66	14.66
14	52	12.05	12.56	17.36
15	52	11.59	12.34	13.76
16	75	26.51	41.32	22.32
17	75	24.49	33.42	21.03
18	75	25.37	32.96	22.87
19	86	151.18	457.93	-
20	86	90.71	269.92	-
21	86	115.45	440.91	-
25	97	723.49	807.32	631.29
26	97	712.59	849.84	587.11
27	97	724.09	805.18	510.97

Appendix C.1

Average xanthophyll contents for samples collected during the thin-layer drying experiment at an airflow of $0.23 \text{ m}^3/\text{sec}\cdot\text{m}^2$. Xanthophyll expressed in terms of lutein.

Air Temperature = 60°C		Air Temperature = 65°C		Air Temperature = 70°C	
Time (min)	Average Lutein (mg lutein/g dry petal material)	Time (min)	Average Lutein (mg lutein/g dry petal material)	Time (min)	Average Lutein (mg lutein/g dry petal material)
270	4.00	*	*	120	5.08
300	5.33	*	*	150	*
330	4.83	*	*	180	*
360	4.05	*	*	210	5.05
390	6.48	*	*	240	5.05
420	2.98	*	*	270	4.97
450	7.53	*	*	300	6.83
480	4.55	*	*	330	10.18
510	5.17	*	*	360	7.47
540	2.20	*	*	390	4.85
570	7.68	*	*	420	7.28
600	3.60	*	*	450	8.03
630	6.49	*	*	480	4.30
660	3.07	*	*	510	3.68
690	3.7	*	*	540	7.33
720	2.45	*	*	570	5.37

* No xanthophyll analysis performed

Appendix C.2

Average xanthophyll contents for samples collected during the thin-layer drying experiment at an airflow of $0.28 \text{ m}^3/\text{sec m}^2$. Xanthophyll expressed in terms of lutein.

Air Temperature = 60°C		Air Temperature = 65°C		Air Temperature = 70°C	
Time (min)	Average Lutein (mg lutein/g dry petal material)	Time (min)	Average Lutein (mg lutein/g dry petal material)	Time (min)	Average Lutein (mg lutein/g dry petal material)
*	*	150	4.80	120	6.60
*	*	180	5.29	150	2.20
*	*	210	5.40	180	9.08
*	*	240	9.68	210	7.70
*	*	270	3.10	240	3.38
*	*	300	3.03	270	1.37
*	*	330	7.25	300	7.06
*	*	360	2.68	330	4.70
*	*	390	3.33	360	2.88
*	*	420	6.18	390	3.58
*	*	450	4.88	420	4.75
*	*	480	8.07	450	6.43
*	*	510	2.40	480	4.33
*	*	540	3.13	510	1.64
*	*	570	3.53	540	1.37
*	*	600	4.90	570	3.73

* No xanthophyll analysis performed

Appendix C.3

Average xanthophyll contents for samples collected during the thin-layer drying experiment at an airflow of 0.33 m/s. Xanthophyll expressed in terms of lutein.

Air Temperature = 60°C		Air Temperature = 65°C		Air Temperature = 70°C	
Time (min)	Average Lutein (mg lutein/g dry petal material)	Time (min)	Average Lutein (mg lutein/g dry petal material)	Time (min)	Average Lutein (mg lutein/g dry petal material)
270	9.74	150	7.60	120	7.15
300	11.96	180	5.12	150	5.18
330	8.97	210	3.90	180	4.36
360	6.68	240	8.25	210	3.00
390	2.30	270	3.97	240	3.97
420	7.49	300	8.23	270	3.06
450	7.26	330	4.62	300	1.25
480	8.29	360	7.27	330	1.81
510	4.68	390	4.13	360	1.62
540	8.82	420	7.50	390	6.75
570	21.53	450	4.10	420	3.45
600	*	480	5.03	450	3.93
630	17.32	510	3.57	480	4.34
660	6.89	540	7.03	510	*
690	8.30	570	6.62	540	3.55
720	8.43	600	9.50	570	*

* No xanthophyll analysis performed

VITA

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