

Modeling of Moisture Sorption Isotherms and Diffusivities of Coconut

*Louis V. Nelson III and Martin R. Okos, Agricultural and Biological Engineering,
Purdue University*

In recent decades, the coconut industry has realized a reduction in its foothold in the world market. With its most valuable products, coconut oil (CNO) and copra cake (CC - product acquired after oil extraction), being placed under intense scrutiny by importers, the demand for these products is continuing to decline as higher quality and cheaper products of approximately equivalent functionality are being implemented (e.g. soybean, palm and sunflower oils). The major cause of the decline in the coconut industry results from the poor quality of products offered for export i.e. high acid coconut oil, products containing unacceptable levels polycyclic aromatic hydrocarbons (PAH), and copra/CC contaminated by aflatoxins (Rouziere, 1993). In addition, stringent limits on the aflatoxin and PAH levels imposed by European nations have resulted in detrimental effects on the coconut industry. Many of these problems are found to arise from inadequate preparation of copra through improper drying and storage and the introduction of PAH through methods such as smoke drying.

Drying has been considered one of the weakest links in the production of high quality copra (Guarte, 1996) and the root of many of the aforementioned problems. The drying process is being studied continuously and new methods of drying that will produce the desired copra products are needed. Improper drying facilitates bacterial degradation allowing it to set in during the early stages of processing and during long periods of storage. This enhances fungal infection and pest infestation when storage conditions allow moisture uptake (McFarlane, 1975 and Guarte, 1996). The actions of these microorganisms increases the free fatty acid content and rancidity and reduces the amount of extractable oil (Cooke, 1931 and Guarte, 1996) resulting in low quality oil and the production of toxic metabolites (aflatoxin). The high content of aflatoxin in the copra and CC and high levels of free fatty acid in CNO are found to be the result of the high moisture content of the copra during storage (Head, 1991). Proper drying is therefore crucial to the production of high quality copra and sufficient drying methods must be employed.

The objective of this paper is to determine and model coconut sorption isotherms and effective diffusivities. The isotherms are being collected at temperatures of 25, 35, 45, 55, and 60°C, humidities up to 80%, and at various thicknesses as small as 100 microns. Though research has been done on the adsorption and desorption (Diamante, 1995; Guarte, 1996; Bustrillos and Banzon, 1949; McFarlane, 1960; Gayerst, 1963; and Pixton and Warburton, 1971) behavior of copra obtained from various drying methods, none has been found on the sorption behavior of fresh coconut. Isotherms will be modeled utilizing two and three parameter equations such as the Guggenheim, Anderson de Boer (GAB), Ferro Fontan, and Henderson among others. The equation of best fit will be determined through non-linear or linear regression (Timmerman et al., 2000) analyses utilized in previous studies. The effective diffusivity approach will be utilized to develop a model that will aid in the prediction of moisture content distribution during drying. This research will prove beneficial in the storage and drying aspects of coconut processing and may later prove beneficial as ready-to-eat coconut (Sinigaglia et al., 2002) becomes of increasing interest to the consuming population, especially in areas where people of island descent (e.g. South Florida) are heavily concentrated.

References

- Bustrillos AD and Banzon J. 1949. The equilibrium moisture of copra at various relative humidities. *Philippine Agriculturist* 33 (2):77-87.
- Diamante LM. 1995. Moisture Adsorption Isotherms of Copra at Different Temperatures. *Annals of Tropical Research* 17: 35-44.
- Gayerst G. 1963. Unpublished work on copra isotherm. Pest Infestation Control Laboratory.
- Guarte R. 1996. Modeling the drying behavior of copra and development of a natural convection dryer for production of high quality copra in the Philippines. Dissertation. University of Hohenheim.
- McFarlane JA. 1960. Unpublished work on copra isotherm. *Stored Product Entomologist in Jamiaca*.
- Pixton SW and Warburton SJ. 1971. Moisture content/relative humidity equilibrium at different temperatures of some oilseeds of economic importance. *Journal of Stored Products Research* 7: 261 – 269.
- Rouziere A. 1994. What technologies can be used to revitalize the coconut sector? A few proposals from CIRAD. *Oleagineux*, 49(3): 115-124.
- Sinigaglia M., Corbo M. D'Amato, D. Campaniello, D., Altieri, C. 2003. Shelf-life modeling of ready-to-eat coconut. *International Journal of Food Science and Technology* 38: 547-552.
- Timmerman E, Chirife J, Iglesias H. 2001. Water sorption isotherms of foods and foodstuffs: BET or GAB parameters?. *Journal of Food Engineering*. 48: 19-31.