9 Nuts, oilseeds, and dried legumes

1 Introduction

A Definitions

Nuts are dry, one seeded fruit, which do not dehisce at maturity, and are usually enclosed by a rigid outer casing or shell. Most nuts grow on large shrubs or trees and are known as tree nuts. Tree nuts include almonds (Prunus amygdalus), hazelnuts (Corylus avellana), pistachios (Pistachia vera), Brazil nuts (Bertholletia excelsa), pecans (Carya illinoensis), coconuts (Cocos nucifera), and macadamia nuts (Macadamia ternifolia). Although not covered strictly by the botanical definition, walnuts (Juglans regia) are usually considered to be nuts. The only major nut not from trees is the peanut (Arachis hypogaea), known as “groundnut” in some countries. Botanically, the peanut is a legume, a member of the pea family, but it will be treated as a nut in this chapter. Illipe nuts (Shorea aptera and related species) contain 50–70% fat and are exported from Southeast Asia as a cocoa butter substitute.

Peanut butter is the finely ground paste produced from (usually) roasted peanuts. In some countries other edible oils or ingredients are added to peanut butter, but with little effect on microbiology.

Peanut sauces, known as satay sauces, are pastes made from dried shelled peanuts, spices and water, usually with other ingredients added. They are widely used in Asian countries, mostly consumed fresh, and are increasingly traded internationally, where they are normally subjected to sterilizing treatments as low-acid products.

Oilseeds are mostly small seeded crops that are grown primarily for oil production. They are drawn from a range of botanical families. Oilseeds include palm nuts (Elaeis guineensis, Ela. oleifera, and hybrids), rapeseed or canola (Brassica rapa, B. campestris), sesame (Sesamum indicum), sunflowers (Helianthus annuus), safflower (Carthamus tinctorius), cottonseed (Gossypium spp.), and cacao seeds (Theobroma cacao). The last named is treated in Chapter 10, along with cocoa butter. Oil from Zea mays, known as maize oil or corn oil, is also an important commodity. Dried coconut is known as copra when sold in large pieces and as desiccated coconut when shredded. Comminuted coconut is known as coconut cream and is usually sold canned as a low-acid food. It is sometimes spray dried and sold as a powder.

Dried legumes are the seeds of leguminous plants, members of the family Leguminosae. Dried legumes that will be considered in this chapter include soybeans and the many other types of beans that are field dried. Fresh legumes are treated under vegetables in Chapter 5.

Coffee is a beverage made by brewing roasted beans of the coffee tree (Cafea arabica, C. canephora var. robusta, or hybrids). Coffee is consumed almost universally and the coffee growing, and manufacturing industries are amongst the largest in international trade. Instant coffee is produced by freeze or spray drying brewed coffee.

B Important properties

Nuts have very high nutritional and calorific values. The pH of all nuts and oilseeds is near neutral, in theory rendering them susceptible to growth of all kinds of microorganisms during development and before natural drying at maturity. In practice, shells provide a highly effective barrier to the entry of bacteria during nut growth. After natural drying, the low aw of most nuts restricts bacterial spoilage or toxin production. However, contamination of nuts may sometimes occur post-harvest, for example,
with salmonellae, leading to concern both directly and with high $a_w$ products to which nuts are added, e.g. dairy products.

In the microbiological context, the most important property of both nuts and oilseeds is their high oil content. This provides a high susceptibility to attack by lipolytic bacteria and by spoilage fungi, with an exceptional potential for mycotoxin production.

Peanuts, with a unique growth habit in soil, are especially vulnerable to fungal invasion before harvest. Many kinds of fungi are found in peanuts, but the presence of *Aspergillus flavus* and the production of aflatoxins are of major concern.

Spoilage and mycotoxigenic fungi sometimes invade other nuts as well, but usually only as the result of insect or mechanical damage (tree nuts) or contamination during drying and processing (pistachios).

Most dried legumes are rich in carbohydrates and low in oils, so they are microbiologically similar to cereals. However, soybeans are up to 20% oil on a moisture free basis (Waggle and Kolar, 1979), so they more resemble oilseeds in their microbiology. Soybeans also contain high levels of protein (40% or more, Waggle and Kolar, 1979), an attractive trait because of the high nutritional quality (Richert and Kolar, 1987).

Fresh coffee beans, known as cherries, are of relatively low nutritional value. The flesh of the fruit must be removed before the beans are fully dried, and this is accomplished by mechanical means or fermentation.

### C Methods of processing

Typical primary processing of all of the commodities considered here involves drying, which commonly takes place in the field. Mechanical drying may be used for some crops in particular localities.

**Tree nuts.** Tree nuts are almost always allowed to dry *in situ*, then harvested mechanically or by hand. Some types are allowed to fall to the ground before collection, resulting in surface contamination by bacteria and fungi. Sometimes dehydration is used in adverse climates or seasons to complete the drying process.

Coconuts are harvested from tall trees either green (for consumption fresh) or at maturity. Nuts are pierced or broken, drained of water, the kernels cut into slices and sun dried to produce copra for oil production. A variety of other coconut products are made using both traditional and modern technologies (Hagenmaier, 1980).

**Peanuts.** Peanuts are harvested by pulling from the ground while high in moisture content and then drying. In developed countries pulling is mechanical. Pulling requires that the stems (pegs) supporting the nuts must be strong and not yet senescent, so the nuts are usually at least partially dried on the upturned bushes to weaken the pegs before mechanical threshing to remove the nuts from the bushes. Newer types of threshers permit mechanical removal of nuts immediately after pulling, followed by mechanical drying. In damp growing areas or seasons nuts are often mechanically dried after threshing to ensure microbiological stability. Peanuts must be dried to about 8% moisture (below 0.70 $a_w$) to be microbiologically stable.

The field drying process is usually quite slow: in Australia field drying takes 6–10 days to complete even under good conditions (Pitt, 1989).

In developing countries, harvesting is commonly carried out by hand. Pulling is aided by the use of hoes or forks, then the nuts are usually removed from the bushes by hand and dried in the sun on hessian or plastic sheets. If weather conditions are good, drying may require no more than 2–3 days. Much longer periods may be needed if conditions are adverse.