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Review

Food processing a tool to pesticide residue dissipation – A review

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ABSTRACT

Food safety is an area of growing worldwide concern on account of its direct bearing on human health. The presence of harmful pesticide residues in food has caused a great concern among the consumers. Hence, world over to tackle food safety issues, organic farming is being propagated. However, due to several reasons, diffusion and acceptance of this approach in developing countries has been very slow. Therefore, it is important in the transient phase that some pragmatic solution should be developed to tackle this situation of food safety. Food processing treatments such as washing, peeling, canning or cooking lead to a significant reduction of pesticide residues. In this background this paper reviews the common food processing operations along with the degree of residue removal in each process. The processes reviewed include: baking, bread making, dairy product manufacture, drying, thermal processing, fermentation, freezing, infusion, juicing, malting, milling, parboiling, peeling, peeling and cooking, storage, storage and milling, washing, washing and cooking, washing and drying, washing and peeling, washing peeling and juicing and wine making. Extensive literature review demonstrates that in most cases processing leads to large reductions in residue levels in the prepared food, particularly through washing, peeling and cooking operations.

Contents

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1. Introduction

Pesticides (insecticides, fungicides, etc.) are used globally for the protection of food, fiber, human health and comfort (Winteringham, 1971). However, their excessive use/misuse especially in the developing countries, their volatility, long-distance transports eventually results in widespread environmental contamination. In addition many older, non-patented, more toxic, environmentally persistent and inexpensive chemicals are used extensively in developing nations, creating serious acute health problems and local and global environmental impacts (Ecobichon, 2001). Further while remarkable progress has been made in the development of effective pesticides, the fact remains that a very small fraction of all applied pesticides is directly involved in the pesticidal mechanism. This implies that most of the applied pesticides find their way as 'residue' in the environment into the terrestrial and aquatic food chains where they undergo concentration and exert potential, long term, adverse health effects (Winteringham, 1971).

Food is the basic necessity of life and food contaminated with toxic pesticides is associated with severe effects on the human health. Hence it is pertinent to explore strategies that address this situation of food safety especially for the developing countries where pesticide contamination is widespread due to indiscriminate usage and a major part of population lives below poverty line. It is therefore of significance to evaluate simple, cost effective strategies to enhance food safety from harmful pesticides for poor populace. Food processing at domestic and industrial level would offer a suitable means to tackle the current scenario of unsafe food.

2. Food processing

The processing of food commodities generally implies the transformation of the perishable raw commodity to value added product that has greater shelf life and is closer to being table ready (Chin, 1997). Unit operations normally employed in processing food crops reduce or remove residues of insecticides and other pesticides that are present in them. These operations such as washing, peeling, blanching and cooking play a role in the reduction of residues (Elkins, 1989). Each operation has a cumulative effect on the reduction of the pesticides present (Geisman, Gunther, & Gunther, 1975).

Washing removes loose surface residues and major portions of polar compounds such as carbaryl. Hot water blanching increases pesticide removal and may hydrolyze substantial fractions of non-persistent compounds. Non-polar pesticides are tenaciously held in the waxy layers of the peel of fruits and vegetables. Peeling and juicing operations usually result in almost complete removal of chlorinated hydrocarbons. The pesticides remain in the solid waste resulting from these procedures (Farrow et al., 1969). This paper reviews the common food processing operations along with the degree of residue removal in each process. The processes reviewed include: baking, bread making, dairy product manufacture, drying, thermal processing, fermentation, freezing, infusion, juicing, malting, milling, parboiling, peeling, peeling and cooking, storage, storage and milling, washing, washing and cooking, washing and drying, washing and peeling, washing peeling and juicing and wine making.

3. Food processing techniques

Food processing techniques implies the set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans or animals either in the home or by the food processing industry. This section reviews the most common food processing techniques that would aid in pesticide dissipation. Table 1 gives details on the effect of various processing techniques on pesticide residue dissipation of different food commodities.

3.1. Baking

Baking is the technique of prolonged cooking of food by dry heat normally in an oven. It is primarily used for the preparation of bread, cakes, pastries and pies, tarts, and quiches. It is also used for the preparation of baked potatoes; baked apples; baked beans. In a study to investigate the effect of baking on pesticide residues in potatoes, profenofos was applied to potatoes one month before harvesting in Egypt. The residue levels detected were 11.48 ppm in fresh potatoes while residues were 0.22 ppm and 0.19 ppm in microwave-baked and oven-baked potatoes, respectively (Habiba, Ali, & Ismail, 1992). During baking when substrate undergo heating, the loss of pesticide residues may be through some physicochemical processes, e.g. evaporation, co-distillation and thermal degradation which may vary with the chemical nature of the individual pesticides. During the process the water contained in the tissue could entrain pesticide molecules (co-distillation) while heat causes evaporation and degradation (Sharma, Satya, Kumar, & Tewary, 2005).

3.2. Bread making

Commercially produced bread is an important component of every day diet in many countries. During bread making process, flour is subjected to biological (fermentation) and physical (baking) transformation (Sharma et al., 2005).

The dissipation of six pesticides was studied during bread making. The bread was prepared from wheat flour spiked at different concentrations (1, 2, 3 and 4 ppm) with endosulfan, hexaconazole, propiaconazole, malathion, chlorpyriphos and deltamethrin. It was observed that in general the range of pesticides degradation was highest (75–89%) in the samples fortified with 1 ppm. However, variation in residue dissipation of individual pesticide during bread making was observed. At 4 ppm level of fortification the degradation was in the order of endosulfan (70%), deltamethrin (63%), malathion (60%), propiaconazole (52%), chlorpyriphos (51%) and hexaconazole (46%). Bread making process involves two major