Predicting Occurrence of Rancidity in Stored Nuts by Means of Chemical Analyses

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Almonds, pecan and macadamia nuts were stored for 16 months at 30°C and a relative humidity of 55%. Rancidity was determined by a trained laboratory panel and peroxide and iodine values determined at 2 monthly intervals, starting at 0 months. Significant changes in peroxide values coincided with the onset of rancidity as determined by the taste panel.

Materials and Methods

Material
Whole, shelled almonds, pecan and macadamia kernels were used.

Method
Whole kernels were stored in open plastic trays at 30°C and a relative humidity of 55%. Samples (250 g) were randomly collected at 2 monthly intervals over 16 months storage period starting at 0 months. Triplicate samples (7 g) of kernels were defatted with petroleum ether (boiling point below 40°C) by Soxhlet extraction (16 h) to obtain oil for chemical determinations. Samples (100 g) were ground and used for sensory evaluation. Whole, shelled kernels (c. 1.5 kg of each kind of nut) were stored at −30°C in double plastic bags as standards for sensory evaluation. Rancidity was determined using the triangle test with a trained laboratory panel (13) and significance was calculated according to the tables of Roessler et al. (14). Iodine numbers were determined in triplicate on five oil samples (200 mg each) according to the Wijs method (15). Peroxide values were done in duplicate on five oil samples (2 g each) according to the AOAC method (15).

Results and Discussion
No significant differences (P > 0.05) in rancidity were detected by the taste panel in almonds after 16 months storage.

Introduction
Extension of the storage period of edible products with retention of quality is one of the major needs of the food industry (1). This applies especially to nuts due to their seasonal availability. Successful storage will ensure the availability of good quality nuts throughout the year. The determination of nut quality is usually based primarily on subjective detection of off-flavours and the most common defect of this type is oxidative rancidity (2). Harris et al. (3) define rancidity in almonds as kernels that are noticeably rancid to the taste. Almonds, pecan and macadamia nuts were stored under different conditions by several researchers (3–7), but the storage ability of the different nuts have not yet been compared in one study. Quality deterioration in almonds must be measured by storing them below 37°C, because accelerated high temperature tests produce a different type of change in quality than that found in almonds stored at lower temperatures (3). No flavour differences in almonds could be detected after 12 months storage at room temperature (8). Macadamia nuts tend to develop rancidity more rapidly during storage at room temperature, but can be stored at 2°C for up to a year. With good ventilation and dry conditions they can be stored for 3 months at room temperature (9). At −18°C they can be stored for 18 months. However, the stability of the kernels to rancidity decreases with increasing storage temperatures (10).

The high lipid content and degree of unsaturation of the fatty acids in pecan kernels complicate successful storage (2). Flavour quality deteriorates due to development of odours and off-flavours. Oxidative rancidity contributes most to the development of off-flavours by formation of oxidative by-products. One of the most effective methods to prevent rancidity in pecan nuts, is to store them under refrigerated conditions (11). The nuts can be stored for a year at 0°C and 70–75% relative humidity, 6 months at 10°C and 4 months at 21°C.

Researchers have traditionally used peroxide values of oils as indicators of quality (5). Increases in peroxide values were associated with the onset of rancidity (5). Iodine values of oils decrease in magnitude when autoxidation occurs, because of oxidation at the double bond sites in the unsaturated oils (3). Decreases in iodine values are not always a definite indication of rancidity. Many factors in the determination method like temperature, reaction time and reagents can contribute to decreases and iodine value determinations are therefore not readily reproducible (12).

The objective of this study was to determine if changes in iodine and peroxide values could be used to predict the onset of rancidity in nuts instead of determination by a trained sensory panel.
In pecan nuts significant differences ($P < 0.001$) in rancidity were detected after 4 months storage and in macadamia nuts after 2 months ($P < 0.01$) and 4 months ($P < 0.001$) storage. The changes in iodine numbers during storage are given in Fig. 1. High iodine numbers (>90) were detected in almonds and pecan nuts, while macadamia nuts had a value of c. 70. These differences in iodine values do not necessarily indicate quality differences, but could be the result of differences in oil composition (10).

Kernels were stored under conditions that promoted the development of rancidity, and a decrease in iodine number as a result of oxidation at the double bond site indicated that autoxidation occurred (3). Small differences in iodine numbers were found in all the oils extracted from nuts after 16 months storage. However, this was not an indication that rancidity did not develop. Abd El-Wahab et al. (7) also found differences of the same magnitude (c. 2 g/100 g oil) in pecan oils after 10 months storage at 30°C, but rancidity was positively identified by means of other analyses. The differences were described as negligibly small (7) and therefore it may be presumed that in this study, no changes in iodine numbers occurred in almonds, pecan and macadamia nuts during storage. This may be due to the complexity of the determination method, because variable iodine numbers occur if the unsaturated linkages are found in abnormal positions in the fatty acids or if they occur in conjugated systems (16). Iodine numbers cannot therefore be implemented on their own to determine rancidity and other more specific analyses are needed as rancidity indicators.

Peroxide values (meq/kg oil) determined during storage are illustrated in Fig. 2. A sharp increase in peroxide value of pecan (0.6-4.9 meq/kg) and macadamia nuts (0-8 meq/kg) occurred during storage. These increases in peroxide values confirm the development of rancidity during storage (5). The increase in peroxide value of oil during storage is attributed to the formation and accumulation of hydroperoxides (7). Peroxide values for almonds on the other hand, change little during storage. Mehran and Filsoof (8) could not determine changes in peroxide value after 12 months storage and this confirmed the good stability of almond lipids during storage. It is difficult to determine from Fig. 2 exactly when rancidity commenced, because no preliminary slow oxidation period occurred. If the results of the sensory evaluation are considered together with the changes in peroxide values, the gradual increase in peroxide value in both nuts commenced between c. 1.5 and 1.6 meq/kg and these points were at 4 months for pecan and 2 months for macadamia nuts. The initial

sharp increase could not have commenced earlier because no preliminary slow oxidation period occurred. Therefore, the formation and accumulation of hydroperoxides (7) may be due to the fact that the critical point for peroxide value of oil during storage is not a good indicator of rancidity.

Conclusion

Changes in peroxide values of pecan nuts during storage. ——, almonds; ·····, pecan nuts; ·····, macadamia nuts

Fig. 1 Mean values (15 determinations) for changes in iodine numbers of different nuts during storage. ——, almonds; ·····, pecan nuts; ·····, macadamia nuts

Fig. 2 Mean values (10 determinations) for changes in peroxide values of different nuts during storage. ——, almonds; ·····, pecan nuts; ·····, macadamia nuts

References

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sharp increase could be considered as the induction period and the critical point for detection was where the taste panel detected rancidity for the first time (Fig. 2). Rancidity might have commenced earlier, but this was the first point where the panel could detect it.

The decrease in peroxide values in pecan nuts at 12 months may be due to changes in vacuum supply during evaporation that lead to elevation of temperature. This causes decomposition of peroxides and thus a decrease in peroxide value.

Conclusion

Changes in peroxide values can be used to predict cognisable rancidity in nuts, without using a trained sensory panel, if the threshold peroxide value for rancidity in each nut is known.

References

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