MICROBIAL CHANGES IN MACADAMIA NUTS FROM HARVESTING TO PROCESSING AND SURVIVAL TESTING FOR KEY ORGANISMS

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ABSTRACT

Surveys of macadamia nuts from tree to consumer pack indicated that high microbial loads occur on external surfaces because of environmental contamination on farms. *Salmonella* were not detected. However, challenge tests with selected pathogens and spoilers in deliberately inoculated kernels indicated that survival could occur for long periods of time, especially at low temperatures and low nut moisture levels. Thus, while the risk of internal contamination with pathogens through natural cracks or during factory cracking may be low, if they gain entry, they may persist until consumption. Handling and monitoring therefore need to be optimised.

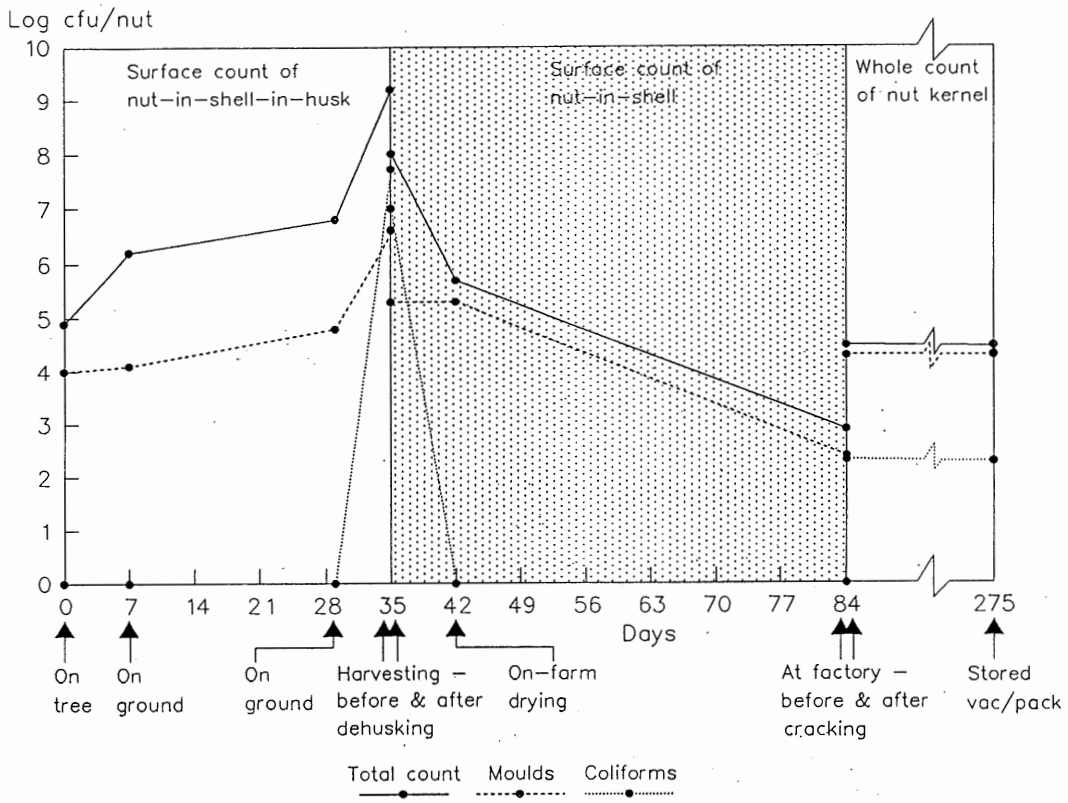
INTRODUCTION

Because macadamia nuts are harvested from ground in orchards where organic fertilisers, eg. chicken manure may have been used, there are concerns for microbial quality of the finished product. It may be possible for pathogens, eg. *Salmonella* and environmental spoilers, eg. coliforms and moulds to gain entry to macadamia kernels through occasional natural cracks in shells or by cross-contamination during factory cracking and processing. This project aims to assess the risks, incidence and potential for development of microorganisms in macadamias between harvesting and consumption.

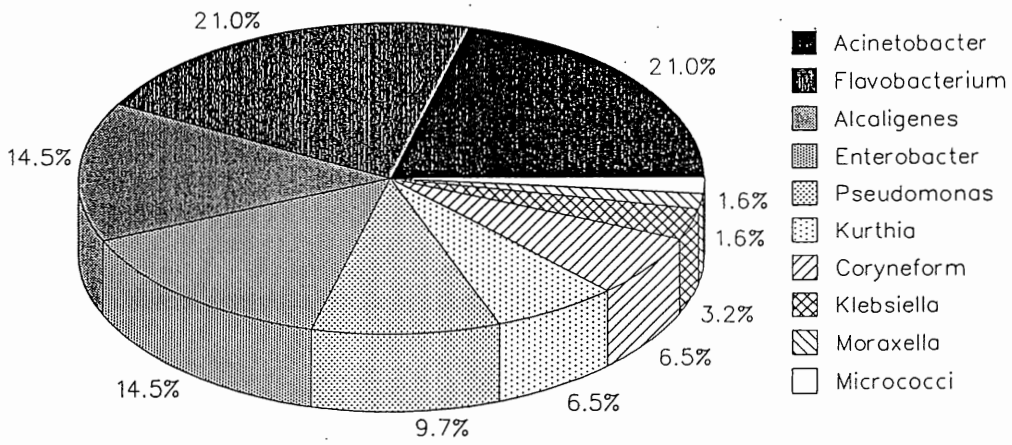
METHODS

Surveys and Isolates: Comprehensive farm and factory surveys were conducted over different seasons, with sampling from tree to consumer pack, to determine microbial loads and types present during ripening, harvesting, dehusking, drying, cracking and processing of nuts. Tests included total bacteria, coliforms, *E. coli*, moulds, *Salmonella* and identification of selected isolates. Microbial counts of nuts-in-shell-in-

Microbial counts of typical nut samples



Frequency of isolates from nuts



husk (prior to dehusking) or nuts-in-shell (between dehusking and cracking) were performed on rinses of husk or shell surface respectively. After cracking, counts were on whole kernels.

Challenge Tests: Challenge testing of macadamia nuts was also performed using selected *Salmonella* and *Escherichia* strains. Nuts-in-shell were selected at different moisture levels (20% to match typical on-ground ripening stage, 10% to match typical end of on-farm drying stage and 1.5% to match typical end of in-factory drying). These kernels were inoculated and stored in-shell at 20°, 37°, 50° or 60°C for regular microbial monitoring.

RESULTS AND DISCUSSION

Surveys

A typical picture of the microbial changes occurring throughout a survey is shown in the first figure.

The total microbial load on the nut-in-shell-in-husk surface increased gradually from 10^5 to 10^8/nut during the first four weeks on-ground ripening. Peak counts of 10^9/nut occurred during the harvesting (very dusty) and fell dramatically to 10^8/nut during dehusking on-farm.

The surface counts of the nut-in-shell then gradually fell from 10^8 to 10^3/nut over seven weeks as ambient on-farm drying occurred. They reached their lowest point of 10^3/nut on arrival at the factory when they commenced the hot air drying step. After cracking, the counts on the nut kernels themselves were slightly elevated (10^4/nut) and stayed at this level during six months storage in vacuum packs.

Salmonella organisms were not detected in any samples and *E. coli* were detected only in a few samples. Mould counts mirrored the total bacterial count changes but were about ½-1 log scales below. Coliform counts tended to be high only at critical stages - harvesting and cracking - and to be much reduced by steps like dehusking.

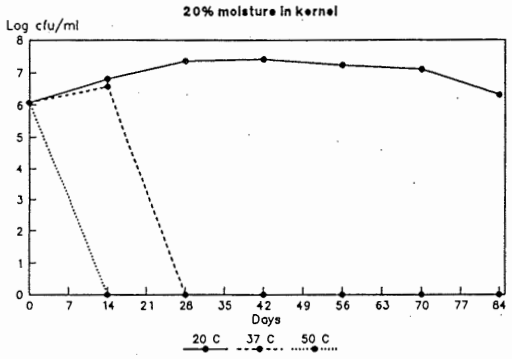
A peculiar feature (not included on graph) was the presence in most samples of a no-gas-from-lactose producing strain of *Enterobacter agglomerans* appearing as pin-point colonies on the coliform plates, with levels mirroring those of the total count. This microbe may therefore be useful as a unique indicator organism for monitoring macadamia processing.

Isolates

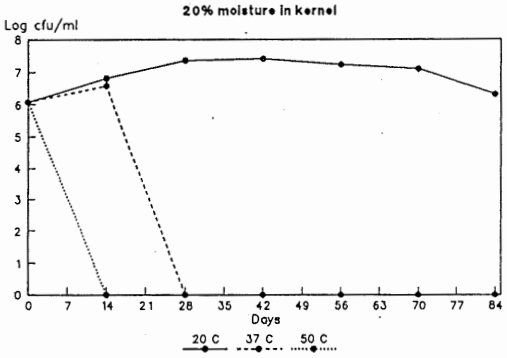
Frequency of the various microbial types among the isolates is indicated in the second figure. They are generally Gram-negative rod-shaped soil organisms, as could be expected when the prevailing environmental conditions are considered.

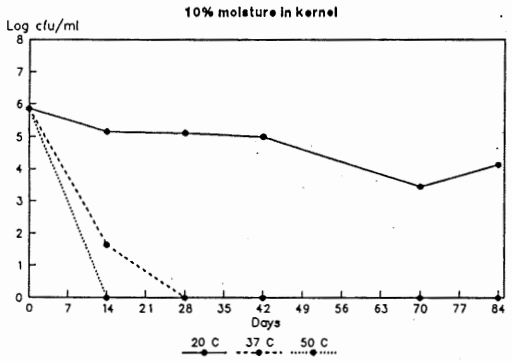
Survival of challenge organisms in artificially inoculated nuts-in-shell

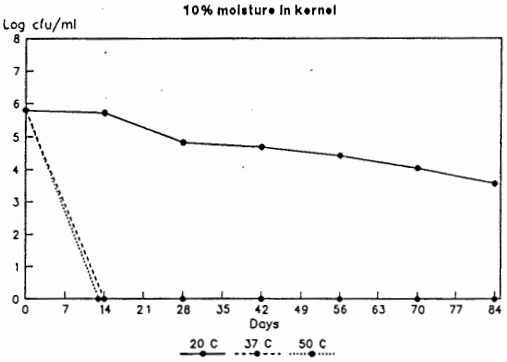
Salmonella typhimurium

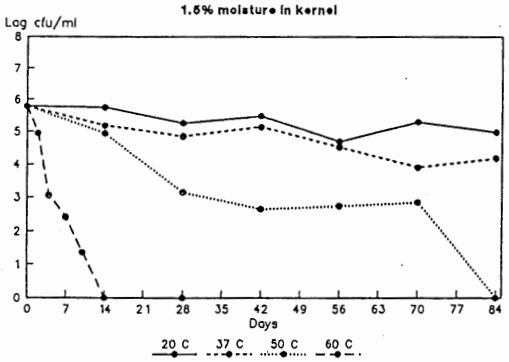


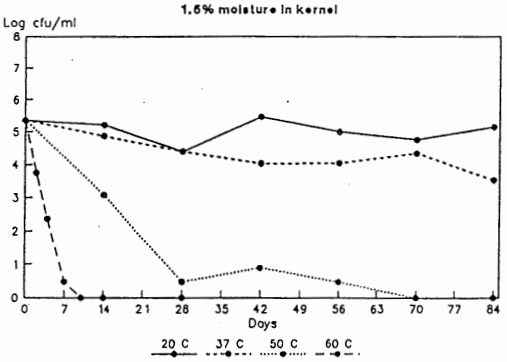
Escherichia coli











Challenge tests

The remaining six figures show typical survival patterns for *Salmonella typhimurium* and *Escherichia coli* in the artificially inoculated (10^5 - 10^6/nut) kernels inside shells. Both organisms behaved in very similar ways, so one could perhaps serve as a model indicator for the other.

Generally speaking, the lowest storage temperature (20°C) resulted in the slowest decline in numbers. At 37° or 50°C the rate of decline was affected greatly by the moisture level, the slowest decline being in the nuts with 1.5% moisture. It was possible for survival under some conditions to occur for 12 weeks or more.

CONCLUSIONS

Although macadamia shell and husk surfaces have very high microbial loads because of environmental contamination, *Salmonella* was not detected in surveys. Key handling steps such as dehusking reduce these loads significantly and drying over long periods further reduces the surface levels, although final counts in packaged kernels remain stable over many months.

Should contamination of kernels with pathogens or spoilers occur at any stage, the prevailing conditions could allow survival for considerable periods. Handling and monitoring procedures will need to be optimised.

Error:

In third figure, 'cfu/ml' should be 'cfu/nut'

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