Drying of Desiccated Coconut on Vibrating Fluid bed Dryer

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DRYING OF DESICCATED COCONUT ON VIBRATING FLUID BED DRYER

Suresh K. Goyel

Dr. Rohit M. Shah

Kilburn Engineering Limited, India.

ABSTRACT

This paper pertains to development of an energy-efficient drying system which can produce hygienic-quality desiccated coconut (DC). As against Conventional Multi-tier Venetian Dryer, Vibratory Fluidised Bed Dryer has been developedwith temperature and fluidisation velocity varying along the length of the dryer. The distributor plate, dedusting and re-injection systems for fly-off were developed for hygienic processing.

After conducting studies on pilot scale, a full size proto-type was put up in a DC Mill in Sri Lanka. This prototype had provision for varying process parameterstto arrive at optimum parameters. The equipmentwasinstalledat a DC Mill in Sri Lankaand experiments condúcted, the results from which have been foundvery rewarding.

INTRODUCTION

Desiccated Coconut is dried either in venetian-type multideck or band-type tunnel dryer. The escalating prices of fuel, quality of product, space requirement, high initial costs and similar other considerations prompted investigation of alternate drying system.

DC contains 50 to 60% moisture on wet basis and the size of particles vary from batch to batch. Vibrating fluidised bed could be an ideal method for uniform drying. Initial trials in a pilot plant followedbyexperimentsonafuil-scaledryer resultedinestablishing optimum parameters for producing quality DC and minimise total initial and operating costs of the dryer.

PROCESSING OF DESICCATED COCONUT

Coconutsaredressed by removing theexternalfibresand breaking open the shells. The core consists of outer skin, water and white matter. The white matter isshredded intofines having particle size between 120 to 2500 microns.

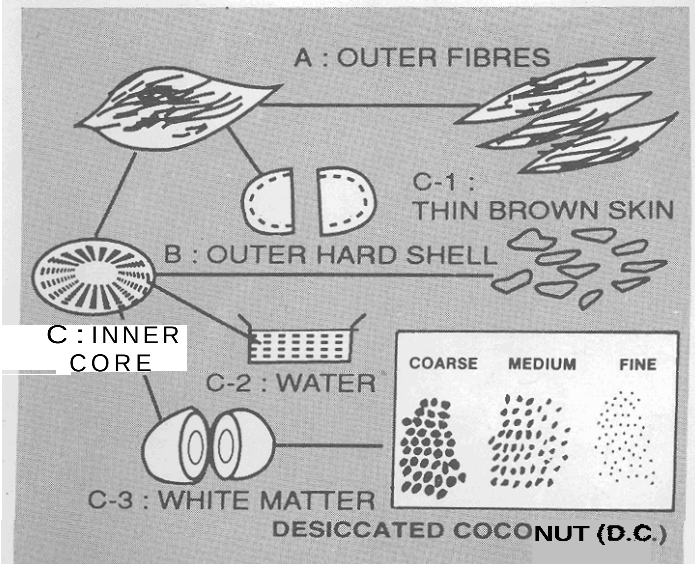

FIG. 1 PROCESSING OF D.C.

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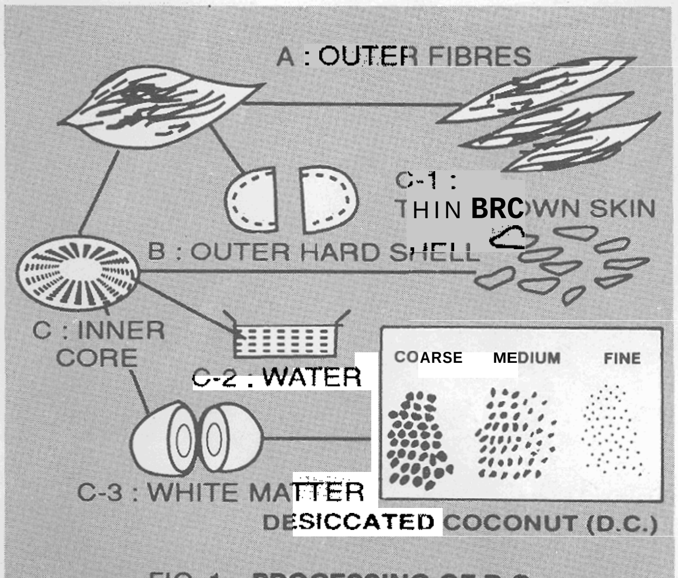

FIG. 1 **PROCESSING OF D.C.**

The shredded coconut is dried to a final moisture content of 2 to 3%. The desiccated coconut so produced is subject to several tests to check its quality.

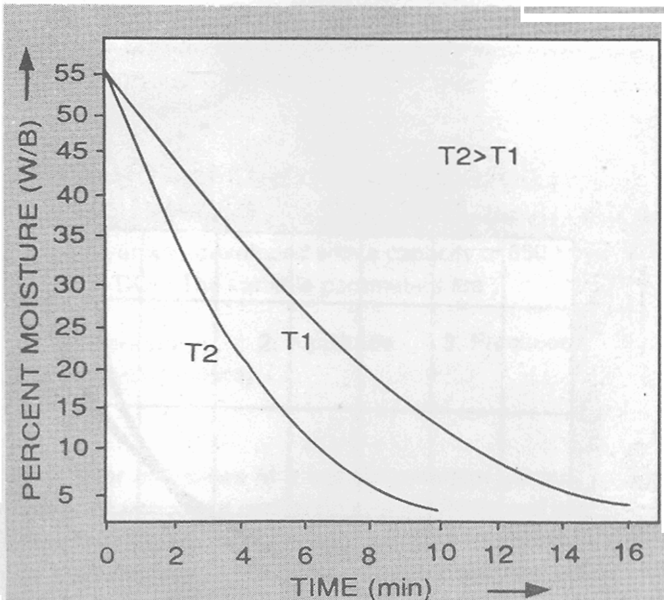

FIG. 2 **DRYING CHARACTERISTICS OF SHREDDED COCONUT**

Fig.2 shows the typical drying curve of DC

Two characteristics of coconut, viz browning due to thermal damage and growth of bacteria largely determine the type of dryer. DC is normally produced in multideck type venetian dryer and band dryer. Thermal efficiency, bacteria count, browning, maintenance and similar considerations dictate effectiveness of the dryer. Oozing of oil takes place if drying is not controlled and it makes the product unacceptable.

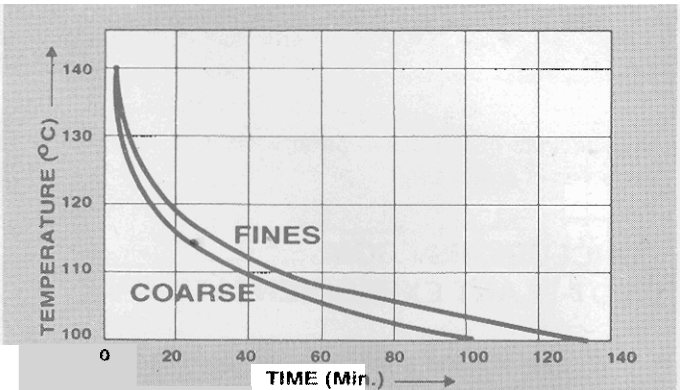

FIG 3 **BROWNING CHARACTERISTICS OF SHREDDED COCONUT**

METHODOLOGY

A pilot-plant Vibrating Fluidised Bed Dryer was designed with adequate features to vary operating parameters like percentage opening, fluidisation velocity, amplitude &frequency of excitation. airtemperature and bed height. Representative samples of wet DC were tested to collect process data to design a full scale plant. Thesamples wereanalysedfor moisturecontent, uniformdrying, brown traces and bacteria. Drying rates, fluidisation parameters, bed heights and effect of temperature were studied.

As quality and bacteria count could not be assessed in entirety, a full-scale plant was manufactured based on the results from pilot-plant tests. Detailed experiments were conducted after carrying out modificationsto compensate for errors in scale-up factors and samples analysed in test laboratory of DC mills. Special tests wereconducted as per norms laid downby Coconut Development Authority, Srilanka for quality of product.

THE PILOT PLANT

The pilot plant comprises of a hot air system, vibrating bed. plenum chamber, drying chamber and excitation system (Fig.1). It has provision to vary drying temperature, geometry of distributor plate, fluidisation velocity, bed heights and excitation parameters. It isa batch typesystem with an evaporationcapacity of upto 5 kg/hr of water.

Fluidisation velocity was varied between 0.6 to 2.8 metres per sec, temperatures between 50 to 150 Deg C, bed heightsbetween 25 mm to 150 mm, residence time between 6 minutes to 35 minutes, frequency of excitation between 200 to 750 rpm and amplitude between 1.5 to 3 mm. Fivedistributor plates were used havingfree area from 8 to 22 percent. Most of the DC had particle size distribution between 120 microns to 2500 µ. The particles generally had oblong/flat shape. The moisture content of feed varied from 45 to 58% and that of the dried product between 1 to 4%.

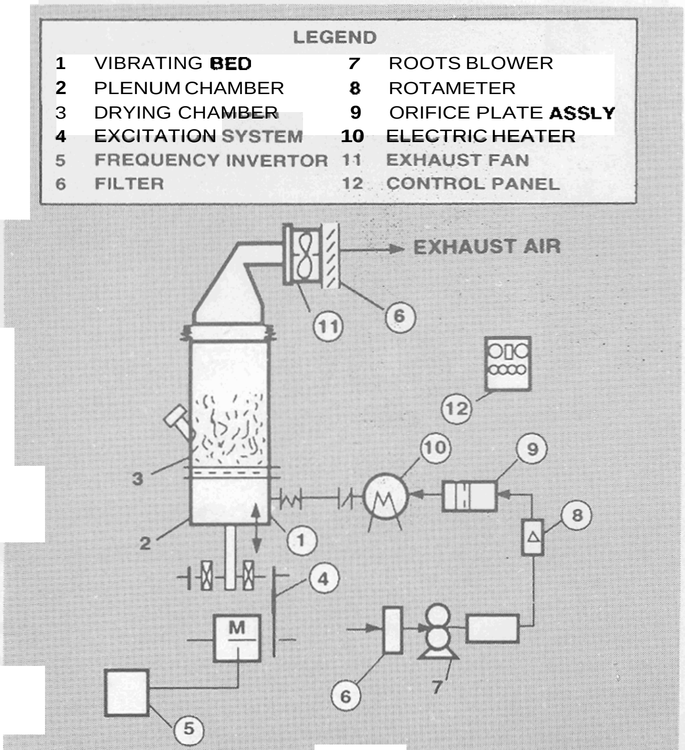

FIG. 4 **SCHEMATIC ARGT. OF PILOT PLANT**

RESULTS FROM THE PILOT PLANT

Fluidisation of DC depended largely on the particle sizedistribution andexcitation parameters. Thedrying ratesshowedsusceptibility to geometry of perforated plates.

DC required controlled drying rates otherwise oozing of oils renders the productunacceptable. The oil must remain in bonded form.

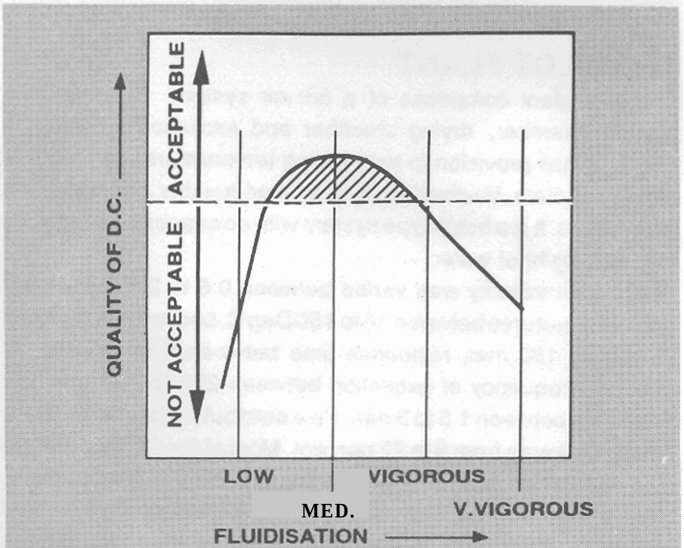

FIG. 5 **EFFECT OF DEGREE OF FLUIDISATION**

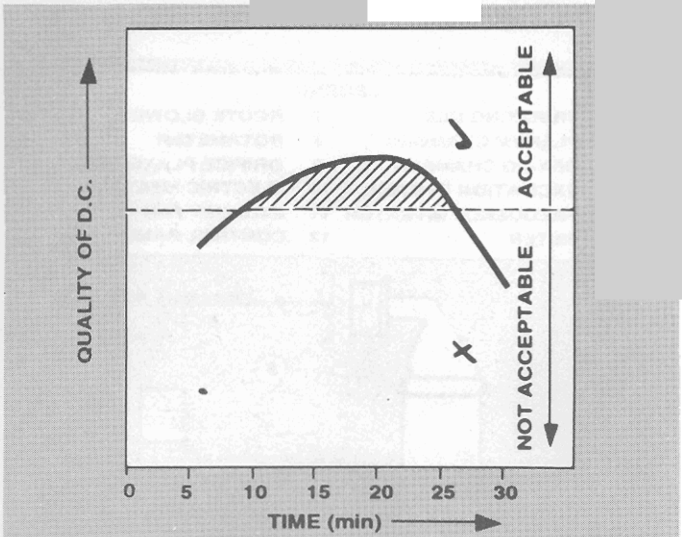

FIG. 6 **EFFECT OF RESIDENCE TIME**

It was also observed that two temperature drying can yield better results in terms of oozing of oil, brown traces, drying time and low bacteria count.

The quality of DC produced largely depended on degree of fluidisation and temperature of drying.

Rate of browning was faster at higher temperatures. (Fig.7).

The mechanicaldesignofthedryingchamberhasan overwhelming effect on generation of brown balls.

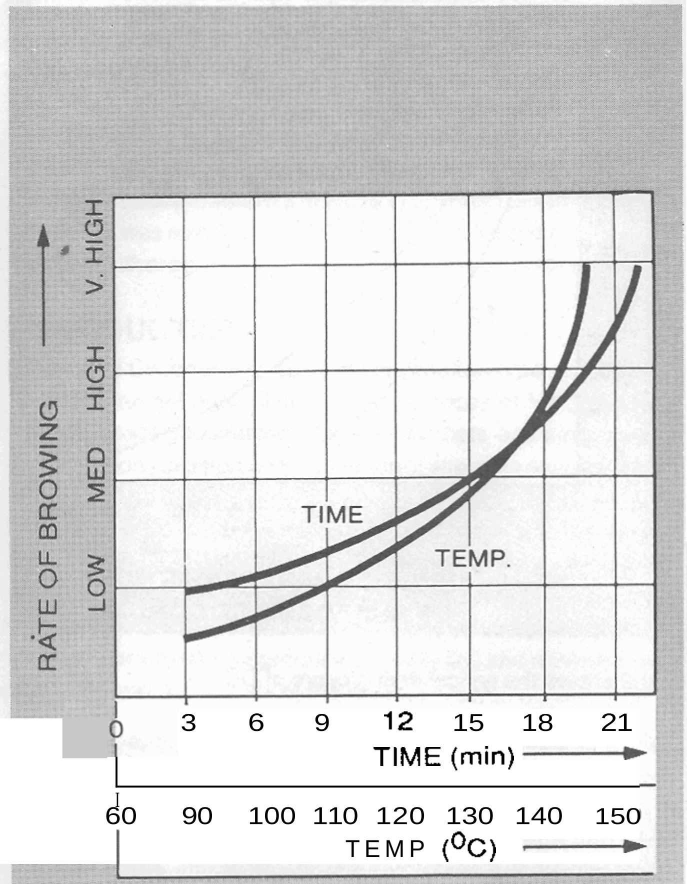

FIG. 7 **RATE OF BROWNING**

The spectrum of the above parameters was very narrow for production of quality DC.

CONCLUSIONS FROM PILOT-PLANT EXPERIMENTATION :

1. Quality of dried product largely depends on time and temperature.
2. Drying characteristics and operating parameters depend on particle size distribution.
3. Oozing of oil and browning can be effectively controlled by judicious selection of time, temperature and fluidisation velocity.
4. The Proto-type Dryer should haveflexibilitytovaryfluidisation velocity, temperature and time to optimize quality of DC.
5. The quality of DC and bacteria counts need to be established by competent test authorities.

FULL-SCALE PROTO- TYPE DRYER

Based on the resultsof experimentson Pilot-Plant, model, a full-scale dryer was developed with a capacity of 550 kg/hr of dried product (DC). The variable parameters are :

1. Temperature 2. Amplitude 3. Frequency and
4. Fluidisation velocity

The dryer comprises of a hot air generator, plenum chamber, drying chamber and oscillation system. Additional features were provided to make it suitable for full scale experimentation as well as production runs. Fig.8 shows schematic arrangement of Full Scale Dryer. The additional features included are : (a) dust collectionsystem. (b) hygienicconstruction, (c) variable excitation, and (d) instrumentation.

The entire construction was in stainless steel and the equipment rugged for industrial application in a food industry.

Theoperating parameters were set as per resultsobtained in pilot plant experimentation. Trial runs were carried and samples of dried product tested by DC mill owners. The parameters were varied to fine tune the dryer and produce product of acceptable quality.

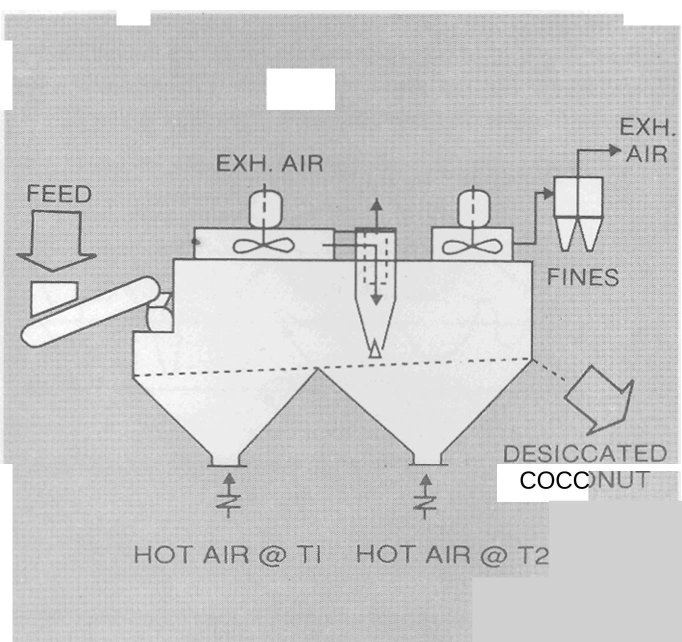

FIG. 8 SCHEMATIC ARGT. OF PROTO-TYPE DRYER

OBSERVATIONS

The DC produced from this dryer showed improved quality and several production runs were taken. The samples of dried product were also sent to Coconut Development Authority for stringent tests. The bacteria count gradually reduced and the DC mill could achieve a very low bacteria count.

DC produced on full-scale plant showed variations inquality as observed on pilot plant. Built-in flexibility provided in full-scale plant enabled fine tuning of thedryer. This flexibility was useful in optimising operating parameters and therefore produce dried product with avery low bacteriawunt, say oftheorderof 390 units instead of 5000 units and more as generally found in DC dried on multi-deck type conventional dryers.

The hygienicconstructionoffullscaledryerwasof paramount importance as small crevices and corners give rise to higher bacteria levels. Higher fluidisation velocity caused oozing of oil, product degradation and fly-off of fines.

Thefuelconsumption wasobserved to be almost half of that required for conventional dryers.

Also the dryer output-to-size ratio was reduced resulting in space savings.

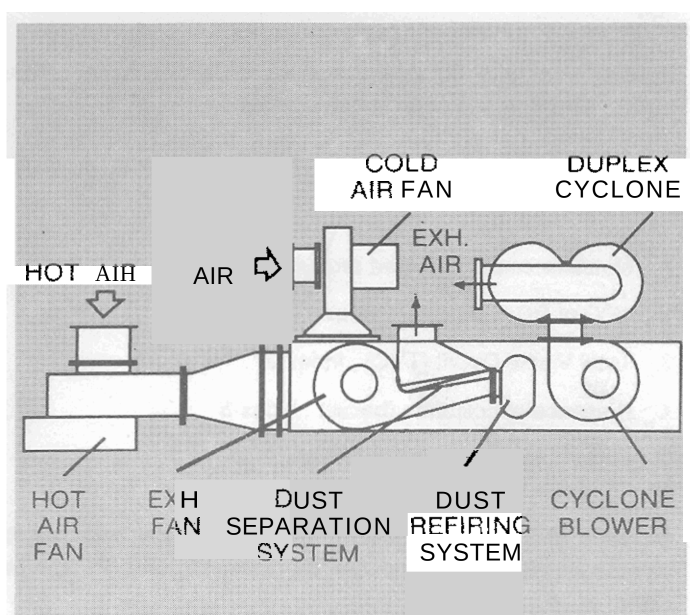

FIG 9 GEN. ARGT. OF DESICCATED COCONUT DRYER

QUALITY OF DESICCATED COCONUT PRODUCED BY PROTO-TYPE DRYER

Quality of DC is of paramount importance to the owners of DC Mill.

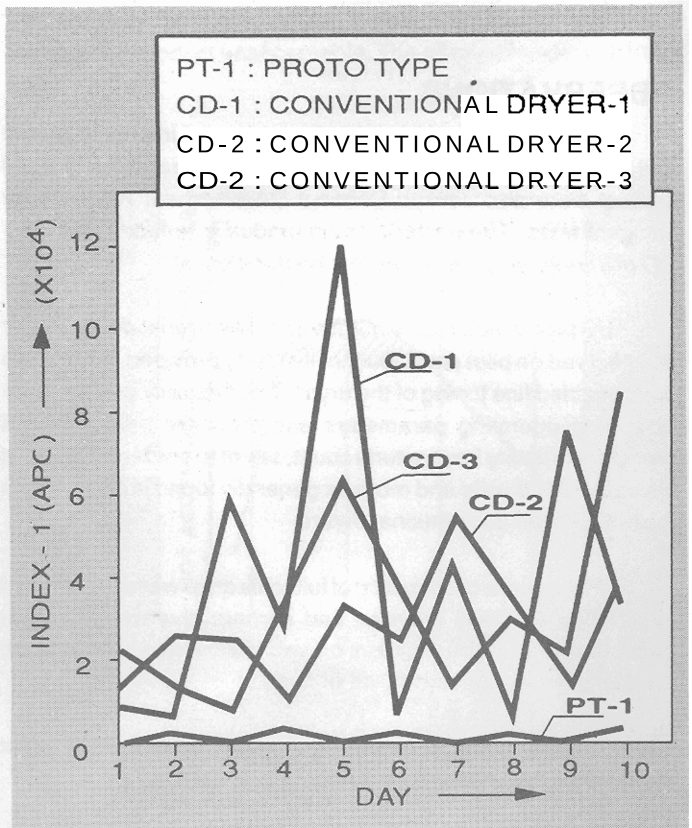

FIG. 10 **COMPARISON OF QUALITY OF D.C. (APC)**

Detailed experimentation and analysis were necessary before putting the dryer into commercial production.

The following parameters are considered to determine quality of product (DC) :

1. Moisture content of dried product.
2. APC of DC produced : Index-1
3. Total Viable Count (TVC) : Index-2
4. Presence of coliforms (bacilli) : Index-3
5. Colour (absence of brown traces)

Samples of dried product (DC) were continually collected to analyse quality of DC produced by Conventional & Proto-type dryer.

The moisture contentof DC was found to be well within acceptable limits.

Evaluation of TVC in the dried product was carried out after reasonable storage. This allowed for resuscitation of bacteria from the heat shocks during drying. Thus TVC is a reliable index of bacterial contamination.

The results are shown in fig.10 to 12. It is observed that there is a drastic reduction in APC value (Index-1) in DC produced by proto-type dryer. The average values of APC for conventional and proto-type were found to be 30,000 and 500 respectively

The Total Viable Count : TVC (Index-2) in DC produced by proto-type dryer was found to be very low.

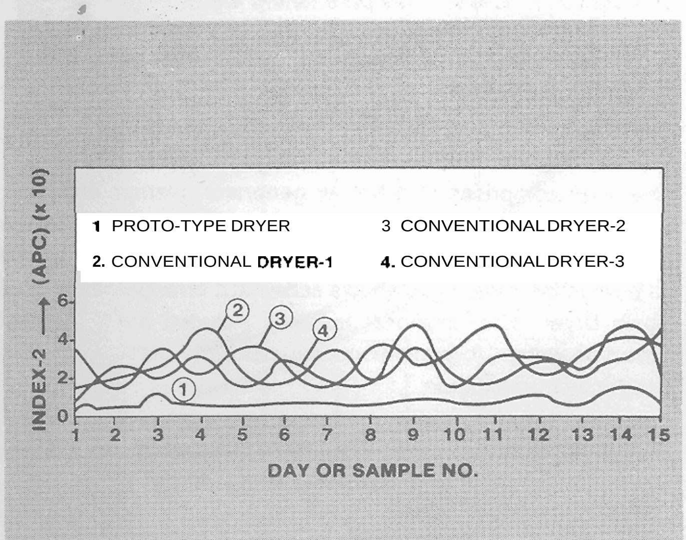

FIG. 11 **COMPARISON OF INDEX-2 (APC) OF D.C.**

Also, this Index varied largely over a period of weeks for conventional dryer whereas the proto-type dryer produced DC consistently with lower TVC.

Index-2 was studied before and after drying and the results were encouraging. For the same wet DC,the TVC variations were significant between conventional and proto-type dryer.

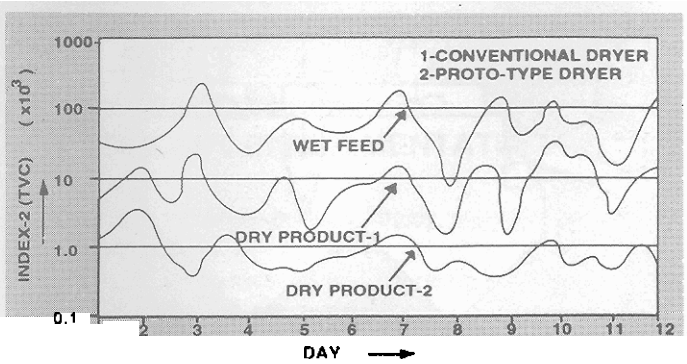

FIG. 12 **COMPARISON OF QUALITY OF D.C.**
PROTO TYPE VS CONVENTIONAL DRYER

Fig.12 illustrates theseobservations. It shows Index-2 for wet DC There is a large improvement in TVC in the DC produced in proto-type dryer.

The presence of coliforms (bacilli) was studied continually during the above period. Analysis of all samples revealed that coliforms were absent. Cpliforms could not beisolated in any instance in DC produced by proto-type dryer.

The abovetestsrevealedthatthequality of DC producedby proto-type dryer was far superior to that produced by conventional dryers.

CONCLUSIONS

The following conclusions were drawn :

1. *Shredded Coconut can beeffectively fluidised and dried on a Vibratory Fluidised Bed Dryer and quality of DC can be improved.

2. Product degradation and oozing of oil can be avoided by selecting proper operating parameters.

3. Two-temperature drying has lethal effect on the bacteria during the drying cycle. It was observed that this dryer produces DC of good bacteriological quality consistently.

4. The energy consumption was reported to be ***50%*** lower than that for conventional dryers.

5. The output capacity-to-space requirement ratio was improved.

ACKNOWLEDGMENTS

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