PRODUCTION OF BAKER' YEAST OF HIGH QUALITY

By

Nadia Rejaat Abdel - Rahman.

M Sc Ain Shams Univ (1967)

Thesis

Submitted in Partial Fulfilment

of the Requirement

for

THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

Food Technology

Food Science Dept.

Faculty of Agriculture

Ain Shams University

1971

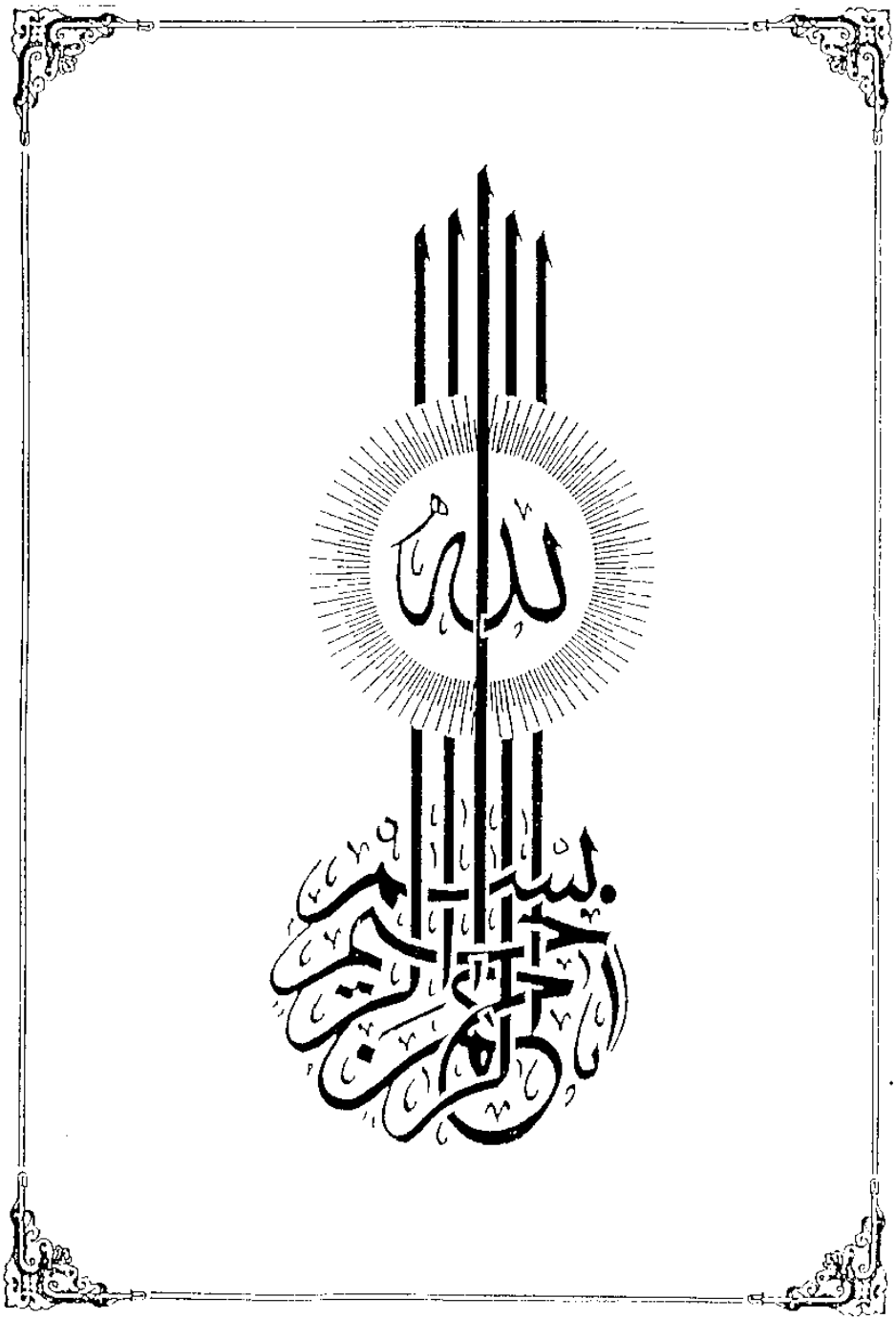
Approved by :

M. Sayed Mohamed

Shahid Toda

S. A. ZAKY

Date : / / 1971



A C K N O W L E D G M E N T

This work had been carried out in the Food Science and Technology Dept., Faculty of Agric., Ain Shams Univ., under the supervision and direction of Prof. Dr. Y.H. Fouda Professor of Food Technology. The writer wishes to express her deepest gratitude to him for suggesting the problem , supervision, progressive criticism, keeping interest, guidance and valuable help.

She is also indepted to Prof. Dr. S.M. Taha the retired Head of the Microbiology Dept. for supervision , valuable suggestions, encouragement and guidance.

...ooOoo...

C O N T E N T S

...ooOoo...

I N T R O D U C T I O N

In the last few decades a rapid evolution of compressed yeast manufacture was noticed. Many investigators were able to obtain yield as near as possible to the theoretical yield by the improvement of non alcoholic processes of yeast cultivation. As a result of these investigations yeast production now forms the basis of vast and rapidly expanding industry. The sugars as the main raw materials for yeast production are available and consequently the production could be increased greatly than the present level. According to Pencl (1969) millions of tons of molasses are produced in Africa, Asia and south America and most of this raw material is considered as waste. Such enormous quantities of raw material could be utilized as a source of carbon for yeast production.

In Egypt the anual production of bakers' yeast increased progressively from 3393 to 3832 tons/year in 1968 and 1969 respectively (U.A.R. Statistical Handbook,1970). This production is still considerably low although molasses as a by-product of sugar industry is available in enormous amounts (220,000 tons in the same year) with a very low price.

In yeast production, sugar and nutrient feeding

should be adjusted so as to be applied exponentially at a rate corresponding to yeast growth. Higher rates of feeding results in considerable fermentation of the applied sugars, and consequently the efficiency of sugar utilization in building cell substances would be low.

Yeast production was found to be dependant on the presence of the raw material, of adequate quantities of the vitamins where certain strains are not able to synthesize. Most yeast strains need for optimal growth the presence of biotin, meso-inositol, pantothenate, thiamine, riboflavin, niacin, pyridoxin and p-aminobenzoic acid.In molasses medium, however, it was reported that only the former three vitamins are needed. In practice manufacturers were able to compensate for vitamin deficiency in their raw materials by mixing a raw material rich in one vitamin and poor in the other with another raw material showing reverse composition.

When all factors that limits yeast growth such as aeration, pH, temperature, feeding modulus, vitamin content of medium, proper strain etc. are optimal, a yield as high as 210 gm fresh yeast per 100 gm sugar in the raw material could be obtained. However, the yield is not the only criterion that is looked for in the production of bakers' yeast. The product should be of high fermentative activity

REVIEW OF LITERATURE

A. Progress in bakers' yeast production :

The purpose of yeast production nowadays is mainly for baking industries. However, considerable amounts are produced to be used as protein, and vitamin supplementation in human or animal diets. Regardless of the purpose of production Manufacturers try to produce the highest amount of yeast from the used substrate.

Earlier production : In the nineteenth century , brewers' yeast, as a by-product from brewery was used as a leavening agent in bread making. According to Frey (1930) although compressed yeast intended for backing began to appear in England, Holland and Germany as early as 1800 , the uses by bakers of yeast obtained as a by-product of brewing and distillins was only gradually supplanted. The first yeast used for bread making was derived from the manufacture of top fermentation beer. Later, this was superseded by the yeast which accumulated on the surface of the spirit mash or at the bottom of fermenting vessels in distilleries. Finally, a method was worked out for growing and pressing distillary yeast specially for baking.

Jorgenson (1948) stated that the so-called"Dutch

method" for production of bakers' yeast was used in the middle of the nineteenth century. The modern development of yeast production began during the World War I. At this time the introduction of molasses as a source of carbohydrates instead of grains caused complete revolution in the technique of yeast production (Sak, 1919 and Hayduck, 1919).

Later on extensive investigations were carried out to improve yeast production and quality.

Feustel and Humfeld (1944) described a new laboratory fermentor for yeast production investigations. It was found that the finer and more uniform air dispersion effected by mechanical agitation is responsible for the excellent results obtained.

Batch production : Walter (1953), White (1954) and Pyke (1958) described the widespread, batch method for commercial bakers' yeast production. Firstly, progressive stages are carried out to prepare the desired inoculum (seed yeast), usually four stages, the first two stages are anaerobic, third semi-aerobic and the fourth aerobic. In the production stage (fifth stage) molasses wort, phosphorus and ammonium salts are added to the fermentor exponentially over a period of 11 hours with vigorous aeration and agitation. It is customary to continue aeration of the

yeast suspension for a further development to ripen or mature newly formed cells before they are harvested. The production stage is usually carried out in a vessel of 45,000 to 225,000 L capacity. At the end of the maturation period the mixture is passed through a battery of centrifuges, washed with water, recentrifuged, filter pressed, and packed in blocks wrapped with paper.

Stuchlik (1960) developed a method for manufacturing biologically active yeast. The yeast was cultivated alternatively on molasses and maltose worts supplemented with phosphoric acid and nitrogenous nutrient salt, as well as ammonia water and maize extract. Cultivation of the 1st and 2nd generations proceeded while molasses wart inflow took 6-10 hrs and following maltose wort inflow (2 hrs). The third generation as a final product was again cultivated on molasses inflow which took 8 hrs. The leavening capacity of the produced yeast was doubled as compared with yeast cultivated on molasses wort only and the leavening period was shortened by approximately 50%.

Tomisek (1960) reported a new method for yeast production in which only molasses, H_3PO_4 and ammonia liquor were used as raw materials. Phosphoric acid was not used as only phosphorus source but its ability to quickly clarify

the molasses solution, making it possible to prepare meshes by a simple continuous method.

Olsen (1960) described a propagation method for yeast production in which the yeast was grown in one section of the fermentor while introducing nutrients and oxygen into it until yeast cells and volume of the medium are at predetermined level. The mixture then passes through different processes for removing gas, to a subsequent section and the process of yeast growth, nutrients, gas addition and gas removal are repeated. The yeast containing medium is then withdrawn from the vessel. During the production, the yeast was fed exponentially with beet molasses along with a combination of NH_4OH and $(NH_4)_2SO_4$. The fermentation was continued for 11 hrs with exponential fed and pure oxygen then one hour without feeding. Yeast recovery by this method reached 83%.

Foda et al. (1971) deviced a simple laboratory fermentor for the study of yeast propagation. Feeding with molasses and mineral nutrients was done in an exponential rate corresponding to the optimal modulus which should be determined to every strain. Aeration was adjusted to give 1.6 gm oxygen per gram sugar fed. It was found that increasing the feeding rate over the optimal feeding modulus decreased the sugar efficiency in production of yeast cells. The

quality of the produced yeast was higher than the available commercial bakers' yeast as indicated by chemical composition, gassing power, and keeping quality.

Continuous production : The studies of Monod (1950) and Novick and Sailand (1950) originated the theoretical and practical basis for the new firmly established technique of continuous culture of microorganisms. Walter(1953) discribed the continuous method for yeast production.This method is affected by continuous addition of strong wort to an extended differential fermentation, and the simultaneous withdrawal of an equivalent volume of fermented wort in order to preserve a uniform volume of wort in the fermentor. The extension of the continuous process is limited by the rapid growth of aerobic microorganism in the wort and although great efforts has been discribed to avoid infection, the fermentation is rarely extended beyond 24 hours with any degree of confidence. The yield in this method is greatly higher than the usual intermittent method provided the contamination is avoided.

Konovalov (1954) described a method for continuous fermentation for the propagation of yeast using a mash prepared from rye. The wort was continuously added at the bottom of the fermentation vessel, and the fermented mash was continuously withdrawn at the top. By adjusting

the rate of addition and withdrawal, yeast concentration in the vessel could be kept constant throughout the propagation process.

White (1954) and Pyke (1958) stated that problems of biological infection leading to poor keeping quality of the produced yeast by continuous fermentation have usually meant that this system will need great deal of further development before it can be completely satisfactory.

Flud and Dann (1957) described an automatic pilot-plant control for yeast production. In this system incremental feeding of molasses for production can be controlled automatically by continuous measurements of the refractive index.

Wenck et al. (1960) discussed theories of semi-continuous and continuous cultivation. For the former one, the fermented substrate was removed at regular intervals (usually hourly) and replaced by fresh substrate - to maintain uninterrupted multiplication of microorganisms without any time limitation, as witnessed by practical results obtained industrially. A certain fluctuation of the actual concentration of the limiting substrate during semicontinuous cultivation affects to a certain extent the physiological state of microorganisms.