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Study on the Quality of Compressed Baker's Yeast in Hasahissa Factory

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ABSTRACT

The main objective of this study was to determine the quality of compressed baker's yeast at Hassahissa Yeast Factory in Sudan. The raw materials used in the production of the compressed baker's yeast were analyzed (molasses, urea, air, water and original strain). Chemical, physical and microbiological analysis were carried out. Chemical and physical analysis for treated molasses showed a decrease in total sugars, total soluble solids, specific gravity and pH value com-pared with the raw molasses. But during processing there was a decrease in pH and Brix values when applying batch process system, during applying continuous process the pH and Brix values were increased with increasing time. The concentration of cream (GPL) and yeast cell concentration (YCC) increased during fermentation to specific time for batch and continuous process systems. Alcohol content was higher in the starter culture compared with the commercial batch. The chemical composition of the final products showed a high moisture content of 70.5%, protein 14.3%, ash 1.7%, fat 1.2% and carbohydrate 12.2%. The activity of yeast and CO_2production were good. The time taken to leaven dough was 75 minutes and the baking test gave reasonable specific volume. Microbiological tests showed no contamination for original strain, but high contamination of air in the surroundings of the plant and factory chambers except culture room. Contamination in treated molasses and water was nil, but urea was contaminated. Also microbial contamination was rather low in starter culture than in the commercial batch. The final product showed a limited degree of contamination. The study recommended the improvement of the hygienic guards for both plant and workers and to use ultra violet sterilization techniques. Also, it is strongly recommended to manufacture dry yeast instead of compressed yeast to overcome the bad weather conditions in the Sudan.

INTRODUCTION

Man used yeast before he knew how to write. Hieroglyphics suggested that the ancient Egyptian civilizations were using living yeast and the processes of fermentation to rise their bread over 5000 years ago. Of course, they didn't know what was responsible for the leavening pro-cess. At that time, a small portion of the dough was used to start or leaven each new bread dough. Later scientific research found that yeast is a microorganism visible only with a microscope.

Specially selected strains of *Saccharomyces cerevisiae* are employed to produce baker's yeast (Christian and Vaclavik, 2003). The first stage of yeast production consists of growing the yeast from the pure yeast culture in a series of fermentation vessels. The yeast is recovered from the final fermenter by using centrifugal action to concentrate the yeast solids. The yeast solids are subsequently filtered by a filter press or a rotary vacuum filter to concentrate the

yeast further. Next, the yeast filter cake is blended in mixers with small amounts of water, emulsifiers, and cutting oils. After this, the mixed press cake is extruded and cut. The yeast cakes are then either wrapped for shipment or dried to form dry yeast (Chen and chigar 2002). Several factors serve to make yeast an ideal source of microbial food. Their nutritive value is high and they are easily cultivated using inexpensive raw materials. Experience already gained in brewing and in the manufacture of baker's yeast has proved useful in developing the yeast industry (Rose, 1999).

The manufacture of baker's yeast in Sudan was started in 1982 in Sudanese Fermentation Industry (SFI). Then in 1990 Hasahissa yeast factory which is owned by Sudanese Development Corporation (SDC) was established. The factory produced active dry yeast but after one year the factory was closed due to lack of proper control for temper-ature and inefficient marketing policies.

In 2003 the factory was again opened after rehabilitation of the machines and the establishment of proper cooling system, but the problem of marketing is still existing. The factory produces now compressed baker's yeast, although the designed capacity is 10 ton/day the actual production – due to marketing problems- does not exceed 2 – 2.5 ton/day.

Objective of the research work:

The overall aim of the study carried out in Hasahissa yeast factory was to evaluate the fermentation process behavior for starter culture and commercial batches. To achieve this objective the followings should be investigated:

1- Evaluation of the hygienic precautions of air condition.
2- Analysis of major raw materials: molasses, urea, water and original strain (brought from India).
3- Carrying out of physical, chemical and microbiological tests during fermentation process in all fermenters.
4- Studying of the differences in the fermentation steps between batch and continuous process systems.
5- Testing of the activity of compressed baker's yeast as final product.

MATERIALS AND METHODS

Materials:

Molasses from El Guneid sugar factory were used as raw materials for fermentation. Urea Gezira company and original culture from University of Gezira were used. Other chemicals used were of analytical grade.

Methods:

Chemical Analysis:

Moisture, fat and ash contents were determined according to FAO (1986) methods.

Nitrogen content was determined by the semi-micro-Kjeldahl distil-lation method as described by Pearson (1970). % Crude protein = % N x 6.25 (protein factor).

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Total carbohydrates were calculated by difference according to Pearson (1970). Total sugars, invert sugars and sucrose found in molasses were determined according to Lane-Enyon method, (Pearson, 1970).

Clarification of molasses and determination of its alcohol content were carried out according to Bhandari (2002).

Physical Analysis:

The total soluble solids and specific gravity were determined according to Indian standard method IS : 1162 (2000).

The potentiometer measurement of pH of the different samples was accomplished using pH meter.

Determination of concentration of compressed baker's yeast was carried out according to Bhandari (2002).

Determination of activity of compressed baker's yeast:

Both, CO_2 production and time taken to leaven a dough were determined according to Bhandari (2002).

Baking test and Bread quality:

The baking test was carried out according to the procedure described by Badi *et al.* (1976).

Concerning the bread quality, the loaf volume expressed in cubic centimeters was determined by the seed displacement method according to Pyler (1973). The specific volume of the loaf was calculated according to the AACC method (1986) by dividing volume (cc) by weight (g).

Microbiological Methods:

The following media were used throughout this study:

Yeast extract agar (Y.E.A), Nutrient agar (N.A), Lysine medium and Fungus media. Moreover, peptone water (oxoid) and cyclohexamide (Actidione) were used.

The preparation and dilution of the homogenate samples were carried out according to Andrews (1992).

Determination of viability of yeast was determined by two methods: by plating according to Andrews (1992) and by haemocytometer according to Bhandari (2002).

Enumeration of the total viable bacterial count in the raw materials, during processing and in the final products were carried out according to Andrews (1992).

Detection of wild yeast in the raw materials, processing line and final products and detection of wild molds in the raw materials, processing line and final products were carried out according to Andrews (1992).

RESULTS AND DISCUSSION

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Chemical and Physical Results:

Molasses before and after treatment:

The chemical and physical analysis of molasses before treatment
gave the following results: The total soluble solids (Brix) was 77%,
specific gravity 1.493, pH value 5.4, total sugars 47.6%, invert sugars 15.2% and sucrose 32.4% (Table 3.1).

After treatment of molasses there was a decrease in total soluble solids (from 77 to 40%), specific gravity (from 1.493 to 1.170), total sugars (from 47.6 to 25.3%), invert sugars (from 15.2 to 9.4%) and sucrose (from 32.4 to 15.9%). The decrease in the above-mentioned parameters was mainly due to addition of hot water and steam.

There was also decrease in the pH value (from 5.4 to 4.5) due to the addition of sulphuric acid (Table 3.1).

These results agree with the results obtained by Osman (2002)

Results of experiments carried out during process Comparison between concentration of compressed baker's yeast (GPL) and time of fermentation:

Usually the starter culture is produced from fermenter A, across fermenter B ending in fermenter C. But sometimes it can be produced from fermenter B ending in fermenter C.

It was observed that the GPL increased weakly in the three fermenters A, B and C at the first four hours of fermentation. Then in fermenter A the GPL showed negligible increase after 16 hours of fermentation, also there was no marked increase in fermenter B after 12 hours of fermentation. This indicates that running the fermentation process after that point is not economical and it should be stopped.

Using the three types of fermenters mentioned above, it was noticed that the GPL increased with increasing of fermentation time.

pH values of different types of processes during fermentation:

When the starter culture was produced from fermenter A the initial pH was 3.81 it decreased till it reached 3.53 during fermentation time and the initial pH for fermenter B was 4.3 it decreased till it reached 3.5, but in fermenter C the initial pH value was 3.6 and increased to 4.72. By commercial batch the initial pH value was 3.2 and it increased during fermentation time, till it reached 5.7.

The decrease of pH value during fermentation (fermenter A and B) was due to the application of batch process system (consumption of nutrients and metabolites activity), but the increase in the pH value during fermentation (fermenter C and commercial batches) was due to the use of continuous process system, by this system the nutrients were fed gradually. These results of pH values agreed with the results obtained by Kristiansen and Ratledge (2001).

Total soluble solids of different processes during fermentation:

When the starter culture was produced from fermenter A the initial
Brix value was 7.5 and it decreased during fermentation till it reached

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3.2. In fermenter B, the initial Brix was 11.3 and it also decreased till it reached 4.5, but in fermenter C the initial Brix was 1.45 and then increased during fermentation till it reached 6.4. The initial Brix of commercial batch was 0.8 and it also increased during fermentation till it reached 7.9.

The decrease of Brix value in fermenters A and B during fermentation was due to the use of batch process system (feeding once at the start of fermentation process), but the increase in the Brix value in fermenter C and the commercial batches was due to the use of continuous process system, which was linked with the gradual feeding of the fermenters.

Comparison between number of yeast cell concentration (YCC) and fermentation during processing:

There was a little increase in yeast cell concentration in all types of fermenters used in this study during the first hours of fermentation. The reason for the low increase in yeast cell concentration from fermentors A, B and C at the first hours of fermentation was due to entrance of the cells in the lag or adaptation phase while the following increase in numbers was due to entrance of the cells in the log or exponential phase, the low increase in number of cells near the end of fermentation process was due to the consumption of nutrients and nature of the strain of compressed baker's yeast used and weather they reached the maximum duplicate rate. Before the yeast cell enters this point, the fermentation process should be stopped because production will be uneconomical and the cells may enter stationary phase and death phase.

Alcohol content at the last stage of fermentation for the starter culture and commercial batch:

The alcohol content at the end of fermentation for starter culture was 1.02% and for the commercial batch was 0.63%. The increase of alcohol content for starter culture compared with commercial batch was since the starter culture uses high concentration of sugars in fermenters A and B at the initial stage of fermentation.

Chemical composition of compressed baker's yeast:

The chemical composition of compressed baker's yeast at Hasahissa Yeast Factory was as follows: Moisture content 70.5%, protein content 14.4%, ash 1.7%, fat 1.2% and carbohydrates 12.2% ,(Table 3.2.).

The results are comparable with the Egyptian standards for compressed baker's yeast (ES664042, 1963) and the values suggested by the Sudanese standards and Metrology Organization (SSMO, 2004)

Activity of compressed baker's yeast:

CO_2 production during dough fermentation:

Compressed baker's yeast in Hasahissa factory has produced 128.5% CO_2 in the first hour of dough fermentation, after two hours the CO_2 produced was 160.71% and at the last hour or after three hours of dough fermentation the CO_2 produced was 175% (Table 3.3).

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Reed and Peppler (1973) reported that yeast produce 350 ml CO_2 in one hour in the dough by 2.5% dry yeast. Oura et al. (1982) reported that the amount of sodium bicarbonate for baking should not exceed 6% of the weight of the dough, this amount gave not more than 214 ml CO_2/hour.

Time needed to leaven a dough:

The time needed to leaven a dough reached 75 minutes in a trial carried out in Hasahissa, but the baking test with specific volume has produced 2.9 cubic centimeter per gram (Table 3.4).

The viability of compressed baker's yeast:

The viability in log_{10} colony forming unit in one gram was log_{10} 9.98 cfu/g. The Sudanese Standards Metrology Organization SSMO (2004) stated that the viable yeast count (viability) for active instant yeast (dry and compressed) should be less than 1 x 10^9 cfu/g of *Saccahromyces cerevisiae.*

Microbiological Results:

Microbiological results of raw materials: log cfu/g

Molasses before and after treatment:

The total viable bacterial count for molasses before treatment was log_{10} 4.84 cfu/g while wild yeasts were log_{10} 2.47 cfu/g and molds were $long_{10}$ 2.00 cfu/g (Table 3.5)

For molasses after treatment, the total viable bacterial count, wild yeasts and molds were not detected, that was due to sterilization process applied.

Water before and after treatment:

The total viable bacterial count for water before treatment was log_{10} 2.79 cfu/ml while wild yeasts were log_{10} 3.25 cfu/ml and molds were log_{10} 1.84 cfu/ml (Table 3.5).

For water after treatment, all microbes were not detected because of the use of a dose of chlorine (0.3 – 0.4 ppm).

Urea before treatment and original yeast culture:

The total viable bacterial count was log_{10} 2.38 cfu/g while wild yeasts were log_{10} 1.00 cfu/g and molds were nil (Table 3.5). The original yeast culture was free of contamination.

Evaluation of the microbiological contamination of the plant, surrounding air and plant units:

The contamination of the air surrounding the plant was too high, the total viable bacterial count was log_{10} 2.49 cfu, the wild yeasts were log_{10} 1.56 cfu and the molds were log_{10} 1.47 cfu after 30 minutes exposure, but the air inside the fermenters was free of microbes because the air before entering the fermenters was passed through an air filter which does not allow the entrance of microorganisms, furthermore the filter should be cleaned continuously and treated by formalin and 95% alcohol. The air inside the plant was also contaminated (Table 3.6).

The contamination of the air surroundings the plant was due to the presence of plant in the industrial area, where the pollution is too high. The contamination inside different parts of the plant was due to opening of doors and windows by workers and also due to insufficient cleaning

and general sanitation. The low contamination of the culture room unit was due to the treatment of this room by formalin.

Microbial results of starter culture during processing:

The contamination (total viable bacterial count, wild yeasts and molds) during production of starter culture from fermenters A and B before inoculation or before charge, after inoculation or after charge and at the final fermentation stages were nil. Because the fermenters A and B use batch process system, and this system works under aseptic conditions, but in fermenter C the contamination had occurred in the final fermentation stage (Table 3.7).

The contamination at the last fermentation stage and separated cream in fermenter C was due to the use of continuous process system and for this system the urea was added without treatment also the fermentter was opened frequently to add the nutrients, that means the contaminated air in process unit can enter inside the fermenter. Furthermore, the separator was not closed completely during separation, then the air enters inside the cream and the process of separation was not hygienic enough, there the technicians touch the working utensils by their hands (without gloves).

Microbial results of commercial batch during processing:

Concerning the contamination of commercial batch during process it was found that the total bacterial count (TBC) was $\log_{10}$ 1.3 cfu/ml, wild yeasts were $\log_{10}$ 3.17 cfu/ml and molds were log 2.00 cfu/ml. At the final fermentation stage the TBC was $\log_{10}$ 3.0 cfu/ml, wild yeasts were $\log_{10}$ 6.41 cfu/ml and molds were $\log_{10}$ 5.77 cfu/ml. At the cream of compressed baker's yeast after separation the TBC was $\log_{10}$ 4.0 cfu/ml, wild yeasts were $\log_{10}$ 7.25 cfu/ml and molds were $\log_{10}$ 5.95 cfu/ml (Table 3.8).

The contamination in the commercial batch was higher than that in the starter culture because the commercial batch has applied continuous process system. In applying this system in Sudanese fermentation industry, it was found that many ingredients were not treated, the fermenter was opened continuously to add the nutrients.

Relationship between contamination of compressed baker's yeast as a final product and time needed for dough leavening:

Compressed baker's yeast as final product with different levels of contamination was used to study the relation between the level of contamination of compressed baker's yeast as a final product and time needed for dough leavening. Four experiments were carried out, where the level of contamination was increased in each following experiment It was noticed that increasing the level of contamination of compressed baker's yeast result in increasing of the time needed for dough leavening (Table 3.9). In the fourth experiment, the time needed to leaven dough was 100 minutes,

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at this point the product was so highly contaminated that the activity was nearly lost, therefore the product was unconsumable.

The contamination of the final product was due to the contamination of the commercial batch product. Furthermore, insufficient cleaning and sanitation of filter press, packing machine, filter and baking units, and workers. Also, the cake was kept open in the filter press and baking unit till the baking operation was finished, the workers mean-while touch the cake with their bare hands without using gloves.

Table 3.1: Physical and chemical composition of molasses from El Guneid factory before and after treatment.

Components	Before treatment %	After treatment %
Total soluble solids	77	40
Specific gravity	1.493	1.17
pH value	5.4	4.5
Total sugars	47.6	25.3
Invert sugars	15.2	9.4
Sucrose	32.4	15.9

Table 3.2: Chemical composition of compressed baker's yeast compared with Egyptian and Sudanese standards.

Parameters Tested	Hasahissa comp. yeast %	Egyptian standards %	Sudanese standards %
Moisture content	70.5	not more than 72	≤ 8
Protein content	14.4	not more than 14	40 – 45
Ash content	1.7	not more than 2.5	≤ 8.5
Fat content	1.2	………………..	…………..
Carbohydrate	12.2	……………….	……………

Table 3.3: CO_2 production during dough fermentation (per hour).

Parameter	Time needed to leaven dough			Standard specification
0	1	2	3	

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CO_2 ml	0	128.5	160.71	175	130 - 160

Table 3.4: Time taken to leaven dough and specific volume during bread making using compressed baker's yeast

Type of test	Obtained result	Standard specification
Time taken to leaven Dough (proof time)	75 minutes	60 – 70 minutes
Specific volume	2.9 cm^3 / g	3 – 3.5 cm^3 / g

Table 3.5: Microbiological analysis of raw materials: molasses, urea, water before treatment, and original culture.

Contaminant Log_{10} cfu/g	Molasses	Urea	Water	Original culture
Total bacteria	4.84	2.38	2.79	ND
Wild yeast	2.47	1.00	3.25	ND
Mold	2.00	ND	1.84	ND

ND = Not Detected

Table 3.6: Microbiological analysis of plant and surroundings air.

Contaminant Log_{10} after 30 minutes exposure	Surrounding atmospheric air	Fermentation units	Filter and packing unit	Chemical analysis lab	Culture room unit
Total viable bacteria	2.49	2.35	1.86	2.16	ND
Wild yeas	1.56	1.67	1.73	1.17	ND
Mold	1.47	1.17	1.39	ND	ND

Table 3.7: Microbiological analysis of starter culture during processing

Item	Contamination log_{10} cfu / ml		
	Total bacterial Count	Wild yeast	Molds
Molasses after treatment	ND	ND	ND

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Fermenter A and B (before charge)	ND	ND	ND
Fermenter A and B (after charge)	ND	ND	ND
Fermenter A and B (ar final stage)	ND	ND	ND
Fermenter C (before charge)	ND	ND	ND
Fermenter C (after charge)	ND	ND	ND
Fermenter C (at the final fermentation stage)	2.3	6.00	3.6
Cream of baker's yeast after separation	3.3	6.3	4.3

Table 3.8: Microbiological analysis of commercial batch during processing.

Item	Contamination log_{10} cfu / ml		
	Total bacterial Count	Wild yeast	Molds
Fermenter C (before charge)	ND	ND	ND
Fermenter C (after charge)	1.3	3.17	2.00
Fermenter C (at the final fermentation stage)	3.00	6.41	5.77
Cream of baker's yeast after separation	4.00	7.25	5.95

Table (3.9): Relationship between contamination of compressed Baker's yeast cream and time needed to leaven dough.

Contmination log_{10} cfu / g			Time needed to leaven dough (min.)
Total bacterial count	Wild yeast	Molds	
4.00	5.30	5.00	75
4.47	7.25	5.95	80
4.82	7.79	6.14	85
5.60	9.07	8.00	100

The author used suitable and good raw materials for compressed baker's yeast production except urea has shown some contamination, needs to be treated. The hygiene requirements of the study plant was not good enough. Whereas the original culture of the compressed baker's yeast used was free of contamination and was of high activity.

There are some problems concerning handling and storage of the compressed baker's yeast for this reason active dry yeast is more suitable for Sudan conditions.

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