EFFECT OF SOME ADDITIVES ON LEAVENERS AND DOUGH QUALITY

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Abstract

The effects of L-ascorbic acid (LAA), sodium stearoyl -2-lactylate (SSL) and sodium metabisulfite (SMBS) at different concentrations on the growth of *Saccharomyces cerevisiae* and two strains of *Zymomonas mobilis* (ATCC 10988 and 29191) in culture media were studied. The behavior of yeast and *Z. mobilis* strain individually and their combinations at different ratios in the present or absent of additives on dough during fermentation and bread baking were also investigated.

Each of L-AA and SSL showed an improving effect on the growing of *S. cerevisiae* and *Z. mobilis* strains in culture media. While adding SMBS inhibited their growth. The growing of *S. cerevisiae* reached its maximum when L-AA was added at level of 300 ppm. At the time when adding 0.4% or 0.6% SSL was the most promising to obtain the maximum growth of *Z. mobilis* especially ATCC 10988 which exceeded that of yeast enhanced by L-AA.

Adding either L-AA or SSL at level of 200 ppm and 0.4%, respectively enhanced each of yeast and *Z. mobilis* and their mixtures to produce more gas, as well, the raising ability of fermented doughs. L-AA or SSL addition were more responsible to raise the gas production and improving its retention in doughs fermented with yeast and *Z. mobilis* mixtures especially, when they added at ratio of 3:1, being close to that of yeasted dough. The best interaction treatments between the studied additives and tested leaveners which produced loaves with high sensory quality, were adding L-AA at level of 200 ppm or SSL at 0.4% in yeasted dough or in doughs leavened with yeast and *Z. mobilis* at ratio of 3:1 and 2:1.

INTRODUCTION

Wheat flour doughs retain their gas so much better than doughs from other cereals for two factors; the first one is the ability of gluten proteins to form thin extensible films. Their easy formation may be related to the properties of gluten

proteins when adsorbed at an air - water interface. Under these conditions they form stable and highly compressible film with time-dependent viscoelastic properties (*Tschoegl and Alexander, 1960*). The second factor refers to the rheological properties of the dough. A bread dough must be sufficient rigid to prevent its rapid spreading under the influence of gravity, or accumulation of the gas cells at its top. On, the other hand, in too stiff dough the gas cells can't expand during proof, or their expansion is accompanied by rupture of the membranes between them, which leads to a coarse crumb. This means that gas retention depends on a balance of properties. This explains why the addition of small amount of oxidizing agents improves gas retention, whereas larger amounts of rapidly acting reagents decrease gas retention *(Marker et al. 1968).* Similarly, the loaf volume reaches a maximum with increasing amounts of oxidizing reagents. With increasing oxidation levels the dough becomes more and more rigid. For most flours this increase in rigidity is desirable. After the proper balance of properties has been attained, a further increase in rigidity reduces gas retention (*Pomeranz, 1971).*

Yeast obviously has an irreplaceable role in bread-making. At least three major functions of yeast in bread baking can be recognized; leavening, flavor development, and dough maturing (*Miller, 1982).* The production of leavening gas under practical conditions is the most important function. The ability of baker's yeast to ferment dough has been related to the amount of fermentable sugars in the flour including maltose produced from starch by hydrolysis. In a leavening process, carbon dioxide is produced by the baker's yeast and entrapped in gas cells formed by gluten films. The microorganisms cannot move in the dough and therefore the stretching ability of the gas cells and consequently, the volume increase and gas production rates depend on the initial number and distribution of the microorganisms in the dough. As already stated, yeast confers flavor to the bread through the by products of fermentation; provides gas to expand the dough during final proof and the early stages of baking, that is necessary to obtain a light crumb texture ; and when used in bulk fermentation process, yeast aids dough development *(Akdogan and Ozilgen , 1992).*

The ability to ferment sugars anaerobically is the major crition for strain selection. *(Reed and Nagodawithana., 1991). Zymomonas mobilis,* a gram- negative, facultative anaerobic bacterium, produces ethanol at a rate three - to four fold faster and with a higher final ethanol yield compared to *Saccharomyces cerevisiae* (Rogeres et al. 1982) . *Z. mobilis* was expected to leaven dough by the carbon dioxide evolved.

However, the use of *Z. mobilis* in bread making has rarely been reported (Viikari, 1988).

Dough conditioners have been used as additives in bakery products to improve dough characteristics, eating and shelf life. They were devided into four categories: surfactants (e.g. sodium stearoyl lactylate), oxidants (e.g. bromate and ascorbic acid), reductants (e.g. L-cystiene) and mixing time reducers (e.g. proteases) *(Stauffer, 1983; Fitchett and Frazier, 1987).* However, *Lang et.al. (1992)* classified the additives according to their function to: vital gluten (regular, modified, and enhanced), oxidants (ascorbic acid, potassium iodate, azodicarbonamide, and potassium bromate), reductant (L- cystiene), surfactants (sodium stearoyl lactylate and sucrose ester, salts (sodium chloride, potassium chloride, potassium nitrate, sodium sulfate), and others (malt and calcium propionate). Across all additives and concentrations, increasing water lengthened the time to midline peak. Cystiene shortened peak times, but the oxidants had little effect neither had a major effect on peak heights. The surfactant sodium stearoyl lactylate increased time to peak but had relatively little effect on peak height. The reductant cystiene reduced total work required to mix to peak by about 20%, but salts increased work by about 40%.

In countries where the low permits it , the treatment of flour with minute amounts of oxidizing reagents is an established practice. When oxidizing agents are used, the situation is the same as for water, salt, and other ingredients, there is an optimum level of addition, and this level depends on the type of oxidant and type flour used ; usually it is about 25mg. per kg. of flour. With mechanical dough development, much larger amounts, about 100mg. per kg. are used (Bloksma and Bushuk, 1988). The oxidation requirements increase with protein content, and furthermore, the requirements are higher for varieties with short mixing times. Not only is the mixing behavior changed when an oxidant is added, but also the loaf volume is affected by oxidants (McRitchie, 1994).

The use of surfactants or emulsifiers in bread baking is so well established that nearly all bread produced in the United States contains one or more surfactants. They are used for various reasons in baking but not for emulsification. They widely used as dough strengtheners and volume enhancers. Certain surfactants improve the grain of bread by creating many small cells that give the bread a fine grain ; this grain is controlled by the number of gas bubbles in dough. All emulsifiers belong to the group of polar lipids. Some of the additives, like mono- and diglycerides, occur

naturally in very small amounts among the wheat lipids. Others are synthetic analogues of polar lipids. It is obvious that the emulsifiers will interact with water to give aqueous phases similar to those of wheat lipids. Furthermore, they will mix with the naturally present wheat lipids and influence their aqueous phase properties. Such molecular mixing always takes place when oils or liquid crystalline lipid phases are exposed to one another the emulsifiers used today are distilled monoglycerides. They are mainly added to complex with amylose (crumb softener) and as aerating agents in cookies and cakes. Second in importance according to volume of application are the diacetyl tartaric esters of monoglycerides (DATEM), which are used as (dough strengtheners). Their effect in baking is to improve mixing tolerance and uniformity of pore structure and also to increase the bread volume. The effect of sodium stearoyl lactylates (SSL) in breadmaking is similar to that of DATEM, and their mechanism of action is the same of polar wheat lipids. (Larsson, 1993).

The present investigation was undertaken to study:

- The effects of adding different concentrations of L-AA, SSL, and SMBS on rheological properties of dough and bread making characteristics.
- The applicability of using *Z. mobilis* as an alternative leavening agent in baking and posibility of replacement baker's yeast by *Zymomonas mobilis* at different ratios with and without the previous additives, on dough raising capacity. Also evaluation of sensory attributes of the final bread made with *Zymomonas mobilis* individually and in selected combinations with *Saccharomyces cerevisiae*, to that made with commercial baker's yeast with and without additives.

MATERIAL AND METHOD

Materials

- Samples of compressed yeast (Misr yeast) containing 30% dry matter were obtained from Grand Cairo Bakeries Co. , El Salam Factory , El Salam City , Cairo , Egypt .
- Strain was isolated from commercial compressed yeast according to *Oda and Tonomura (1993).* Active dry yeast (Instant Success) manufactured by S. I. Lesaffre. 75001- Paris- France. Obtained from Soudanco. S. A. I. (The agent in Egypt).

- *Zymomonas mobilis* (ATCC 10988, ATCC 29191) were obtained from Microbiological Resource Center CAIRO MIRCEN, Faculty Of Agriculture, Ain shams University,Cairo , Egypt .

Cultivation Media

Saccharomyces cerevisiae

It was cultured in 5 ml of YPD medium containing1% yeast extract , 2% peptone, 2% glucose . The broth of this seed culture was inocubated into 1L of the same medium and statically incubated for 24 hours at 30°C Cultured cells were harvested by centrifugation for 15 min. at 6000 rpm, and washed twice with 1 liter distilled water. The dry weight was determined by drying 1 gm of this cells at 105° C for 3 hours, and calculated by the difference in weight before and after drying according to Egyptian Organization for Standardization (1971).

Zymomonas mobilis

Zymomonas mobilis strain was grown in 10 ml of RM medium containing 2% glucose, 1% yeast extract and 0.2 % $KH_2 P O_4$ (pH 6) in test tube . The broth of this seed culture was inoculated into 1L of the same medium in a 2-liter flask and incubated for 24 hours at 30 c°. Cultured cells were harvested by centrifugation (5 min. at 9000 rpm) then washed twice with one liter distilled water .To determine dry weight, 1gram of these cells was dried at 110 °c for 5 hours in petry dish . The difference in weight before and after drying was expressed as dry weight according to Oda and Tonomura (1994).

Wheat Flour

American hard red winter wheat flour, 72% extraction (moisture 13.8% , ash 0.51% - protein 11.92 % - wet gluten 33.6 % and falling number 385 sec) was obtained from South Cairo Flour mills Co. , Giza , Egypt.

Additives agents.

L - Ascorbic acid (LAA), sodium stearoyl -2-lactylate (SSL) and sodium metabisulfite (SMBS) were obtained from Crystal Food Additives Co., (CFA), Giza , Egypt .

METHODS

Pan bread making

The straight dough process was carried out according to the method outline by Kent-Jones and Amas (1967).

Analytical methods

Determinations on culture media

Total Plat Count (T.P.C.)

The total viable count of Saccharomyces and Zymomonas cells was determined by plating on agar medium and incubated at 30 °c for 48 hours (Simpson and Tracey, 1987).

Acidity

It was determined as percentage of lactic acid according to the AOAC (1990) Fermentograph test.

This test was carried out according to the method described in the AACC (1983) .

Sensory Evaluations

The external [crust color, symmetry of form, evenness of back, character of crust and break & shred] and internal [crumb color, texture, grain, taste and odor] characteristics of the produced pan bread were scored using the report sheet according to *Abd- EL Rahim, 1992.*

Statistical Analysis

The baking measurements and sensory evaluations data were exposed to proper statistical analysis of variance according to Larmond, (1970). LSD test at 5% concentration of significance was used to compare between means.

RESULTS AND DISCUSSION

Effect of additives on growth and activity of *S. cerevisiae* and *Z. mobilis* on culture media

Data in Table (1), revealed that L-ascorbic acid was more effective in enhancement the growth of yeast cells than the anaerobic *Z mobilis* bacterium. However, in control treatment the total count of *Z mobilis* (10988) increased from $1.5x10^6$ at starting point reached to $1.8x10^9$ with advancing the time to 24 hours .The corresponding percentage obtained in yeast blank treatment when its cells increased from $8.1x10^4$ to $6.0x10^7$ indicating faster growing of *Z mobilis* than yeast without additives under the same conditions. This observation probably owing to fast sugar utilization by *Z mobilis* compared to yeast. In *Z mobilis* , the monosaccharides glucose are transported into the cells by a facilitated system , and metabolized via the Entner - Doudoroff pathway known as typical oxidative glycolysis , as reported by DiMarco and Romono (1985) . In this respect , Park and Boratti (1993) revealed that half the

soluble proteins in *Z mobilis* are enzymes involved in the Enter - Doudoroff pathway of glucose degradation ; therefore this species gives rapid sugar utilization in comparison with yeasts using the classic glycolysis pathway .

As shown in Table (1), the total count of strain *Z mobilis* ATCC 29191 bacterium cells increased with delaying incubation time and increasing L-ascorbic acid concentration incorporated in culture media. The count increased from $9.0x10^5$ at zero time reached to $2.3x10^9$, $2.5x10^9$ and $2.7x10^9$ when L-ascorbic acid was added at levels of 100, 200 and 300 ppm, respectively in comparison to $1.6x10^9$ in control. These increases were by 43.8, 56.3 and 68.8% more than the control, for the above respective counts at the end of experimental time compared to corresponding percentages of 12.5, 43.8 and 56.3% of *Z mobilis* ATCC 10988 under the same conditions.

The acidity with both *Z mobilis* ATCC 10988 and *Z mobilis* ATCC 29191 strains, showed slight differences between the control and treated media with L-ascorbic acid. It increased from 14.4% at the initial point reached 16.2% after the first 12 hours in control and treated media with 100,200 and 200 ppm L-ascorbic acid. This value was kept constant with advancing the time to 18 hours in the two strains where the acidity increased after that to 19.8% during the last 6 hours . While with Saccharomyces cerevisiae, the acidity increased from 23.4, 23.4 %, 25.2 and 25.2 % at zero time for control and 100, 200, and 300 ppm ascorbic acid to the same value of 25.2% after 24 hours for control and all consentration of ascorbic acid.

Data in table (2), showed the effect of sodium stearoyl lactylate (SSL) emulsifier added to culture media on the growth and activity of Saccharomyces cerevisiae and Z mobilis strains during 24 hours. The total count of viable cells *of Zymomonas* (10988) increased with increasing SSL concentration and the time of cultivation. The total count increased from $1.5x10^6$ at initial time reached $3.9x10^9$, $9.6x10^9$ and $9.8.0x10^9$ when SSL was added to media at the respective concentrations of 0.2, 0.4 and 0.6%. These increases were by 116, 433 and 444 % , respectively more than the control having a count of $1.8x10^9$

Data also showed that, the growth and activity of Z mobilis (ATCC 29191), The total count increased from $9.0x10^5$ at initial time reached $2.3x10^9$, $2.5x10^9$ and $2.7.0x10^9$ when SSL was added to media at the respective concentrations of 0.2, 0.4 and 0.6%. These increases were by 43, 56.2 and 68.8 %, respectively more than the control having a count of $1.6x10^9$. While in yeast cells percentage being only 25 , 40 and 53.3% more than the control as affected by SSL added at the above same

concentration to culture media This given data cleared that SSL emulsifier had an excess effect on growth of *Z mobilis* ATCC 10988 compared with other strain ATCC 29191, however it had lesser effect on yeast growing

The acidity with both *Z mobilis* ATCC 10988 and *Z mobilis* ATCC 29191 strains, showed slight differences between the control and treated media with SSL . It increased from 14.4% at the initial point reached to 19.8% after 24 hours for all concentration of *Zymomonas (*10988) and *Zymomonas (*29191). However, the acidity of *Saccharomyces cerevisiae*, gradually increased from 23.4 % at zero time to 25.2 5 after 24 hours for control and all consentration of SSL

In regards to Table (3), it was clearly noticed that SMBS adversely affected the growth of *Z mobilis* ATCC 29191. As the concentration of SMBS raised up , the growth of bacterium cells dominated . The total count gradually decreased from $9.0x10^9$ at the beginning reached $1.5x10^9$, $1.3x10^9$ and $1.2x10^9$ after 24 hours in the presence of 0.001, 0.002 and 0.003% SMBS, respectively in culture media . The corresponding data obtained from the same table for the other strain ATCC 10988 and *Saccharomyc serevisiae* indicating that SMBS had practically the same detrimental effect.

Fermentograph data

Table (4), summerized the effects of studied additives L.AA, SSL and SMBS on fermentative ability of yeast and Z mobilis or their mixtures in wheat flour doughs. The obtained data revealed that the compressed baker's yeast was sufficient to produce carbon dioxide more than Z mobilis during fermentation time. The total gas production was 850 and 720 ml for the respective microorganisms after 2 hours . The more increase in gas production by the yeast can be explained that the yeast can converted the fermentable sugars to carbon dioxide and ethanol. In addition, it also fermented the supplement of sugar formed during fermentation by the action of amylases on available starch. However, Z mobilis fermented only the added glucose and the small amount of sucrose in wheat flour; while it was unable to ferment maltose produced from the enzymatic hydrolysis of wheat starch. As the concentration of yeast increased in its mixture with Z mobilis, the gas production increased in fermented doughs. It reached its maximum volume of 790 ml when yeast was presented at the level of 75% in the mixture.

From the same Table it could be noticed that adding either L.AA or SSL at concentrations of 200 ppm and 0.4%, respectively accelerated the used

microorganisms and their mixtures to produce more gas. The gas produced by yeast reached to 940 and 930 ml in the present of L.AA and SSL, while the corresponding volumes produced by *Z mobilis* were 820 and 810 ml, respectively. It seems that adding the previous agents were response to raise the gas production of yeast and *Z mobilis* mixtures especialiy, when the yeast was added in its mixture with *Z mobilis* at the ratio of 3:1. At this ratio, the recorded gas production in the presence of L.AA and SSL was 920 and 900 ml, respectively being close to that of yeasted doughs (940 and 920).

Opposite effect, however, was found as a result of adding SMBS at 0.002%. It reduced the gas production to 740 and 710 ml in fermented doughs by yeast and *Z mobilis*, respectively. Consequently, it reduced also the gas production in doughs fermented by the mixtures of used strains to range between 680-710 ml .

In conclusion, the improving effects of L.AA and SSL as well as the inhibition effect of SMBS were refereed to their action on the growing of yeast and Z mobilis as previously discussed.

Sensory characteristics

Fresh loaf samples (pan bread) baked from fermented doughs with *S. cerevisiae*, *Z. mobilis*, or their combinations; and treated with L-AA, SSL or SMBS, were tested. The external and internal characteristics were scored and the means of score values are presented in Table (5). Total score values of yeasted loaf were 91.5, 91.5 and 81 % for yeasted dough treated with ascorbic acid at 200 ppm, SSL at 0.4% and SMBS at 0.002 % respectively, compared to 88 % for untreated dough. However, loaves obtained from dough fermented with yeast and *Z. mobilis* at ratio of (3:1) received total score value of 89.0, 88 and 80 for the same additives respectively compared to 88 % for control, followed by that with their mixture at the ratio of (2:1) : 88.5, 87 and 79.5 compared to 88 % for control. Thereafter, the total score values significantly decreased with decreasing the ratio of yeast to *Z. mobilis* in the mixture of leaveners, till reached the lowest score values of 83, 81.5 and 74 % for dough treated with ascorbic acid at 200 ppm, SSL at 0.4% and SMBS at 0.002 % respectively, compared to 81.5 % for untreated dough.for the loaf from fermented dough with *Z. mobilis* alone.

Practically, it could be concluded that all combinations contained yeast with *Z. mobilis* gave bread with accepted sensory quality. The obtained data also indicated no differences between the addition of SSL and L-AA at the concentrations of 0.4% and 200 ppm, respectively to yeasted dough in improving bread quality. These findings agree with reports of Tsen and Hoover (1971) and Tenney (1978).

It could be observed that L-AA or SSL are important in improving baking potential of pan bread. The improvement effect of L-AA was due to its strengthening the protein phase in the dough, which enhanced its ability to stretch into thin layer and retained more gas during fermentation and baking. However, the function of the surfactant SSL as crumb improving agents is closely related to its interaction with starch. When the gelatinization start, however, it form an aqueous liquid crystalline phase, which increase its degree of dispersion in the dough and by that, complexing reactions with amylose and amylopectin take place during gelatinization step, resulted in crumb softening and its better chewability. The deleterious effect of adding SMBS in dough on sensory characteristics of baked loaves may be due to its decreasing the crosslinking which caused a considerable rheological effect, it reduced the glutenin polymers and increased both the viscous and elastic component of dough deformation and by that, impaired crumb texture and obtained open grain with big holes.

These observations are in good agreement with those of Grant and Sood (1980a); Junge and Hoseney (1981) ; Grosch (1986) ; Moore and Hoseney (1986) ; Larsson (1993) ; Wel Dong and Hoseney (1995).

Table 1. Effect of ascorbic acid (LAA) concentration on the growth and activity of *Saccharomyces cerevisiae, Zymomonas* (10988) and *Zymomonas* (29191)on culture media during 24 hours

Incubation T.(hr)	Ascorbic acid																							
	Saccharomyces cerevisiae								*Zymomonas* (10988)								*Zymomonas* (29191)							
	Blanck		100 ppm		200 ppm		300 ppm		Blanck		100 ppm		200 ppm		300 ppm		Blanck		100 ppm		200 ppm		300 ppm	
	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %
0	$8.1x\ 10^4$	23.4	$8.1x\ 10^4$	23.4	$8.1x\ 10^4$	25.2	$8.1x\ 10^4$	25.2	$1.5x\ 10^6$	14.4	$1.5x\ 10^6$	14.4	$1.5x\ 10^6$	14.4	$1.5x\ 10^6$	14.4	$9.0x\ 10^5$	14.4	$9.0x\ 10^5$	14.4	$9.0x\ 10^5$	14.4	$9.0x\ 10^5$	14.4
6	$7.9x\ 10^5$	23.4	$8.9x\ 10^5$	23.4	$10.6\ x10^5$	25.2	$11.5\ x10^5$	25.2	$1.8x\ 10^7$	14.4	$2.0x\ 10^7$	14.4	$2.3x\ 10^7$	14.4	$3.0x\ 10^7$	14.4	$1.8x\ 10^6$	16.2	$19.0\ x10^6$	16.2	$22.0\ x10^6$	16.2	$26.0\ x10^6$	14.4
12	$2.6x\ 10^6$	23.4	$3.9x\ 10^6$	23.4	$4.9x\ 10^6$	25.2	$5.4x\ 10^6$	25.2	$9.0x\ 10^7$	16.2	$16.5\ x10^7$	16.2	$22.5\ x10^7$	16.2	$23.6\ x10^7$	16.2	$7.0x\ 10^7$	16.2	$14.8\ x10^7$	16.2	$21.5\ x10^7$	16.2	$23.0\ x10^7$	16.2
18	$2.3x\ 10^7$	25.2	$3.0x\ 10^7$	25.2	$3.7x\ 10^7$	25.2	$4.8x\ 10^7$	25.2	$4.2x\ 10^8$	16.2	$8.9x\ 10^8$	16.2	$12.3\ x10^8$	16.2	$13.4\ x10^8$	19.8	$3.4x\ 10^8$	16.2	$7.9x\ 10^8$	16.2	$8.8x\ 10^8$	16.2	$11.3\ x10^8$	19.8
24	$6.0x\ 10^7$	25.2	$10x10^7$	25.2	$12.0\ x10^7$	25.2	$13.0\ x10^7$	25.2	$1.6x\ 10^9$	16.2	$1.8x\ 10^9$	19.8	$2.3x\ 10^9$	19.8	$3.5x\ 10^9$	19.8	$1.6x\ 10^9$	16.2	$2.3x\ 10^9$	19.8	$2.5x\ 10^9$	19.8	$2.7x\ 10^9$	19.8

Table 2 . Effect of sodium stearoyl lactylate (SSL) concentration on the growth and activity of *Saccharomyces cerevisiae, Zymomonas* (10988) and *Zymomonas* (29191) on culture media during 24 hours

Incupation T.(hr)	SSL																							
	Saccharomyces cerevisiae								*Zymomonas* (10988)								*Zymomonas* (29191)							
	Blanck		0.2%		0.4%		0.6%		Blanck		0.2%		0.4%		0.6%		Blanck		0.2%		0.4%		0.6%	
	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %
0	$8.1x10^4$	23.4	$8.1x10^4$	23.4	$8.1x10^4$	23.4	$8.1x10^4$	23.4	$1.5x10^6$	14.4	$1.5x10^6$	14.4	$1.5x10^6$	14.4	$1.5x10^6$	14.4	$9.0x10^5$	14.4	$9.0x10^5$	14.4	$9.0x10^5$	14.4	$9.0x10^5$	14.4
6	$7.9x10^5$	23.4	$9.2x10^5$	23.4	$9.3x10^5$	25.2	$9.6x10^5$	25.2	$1.8x10^7$	14.4	$12.7x10^7$	16.2	$13.4x10^7$	16.2	$14.1x10^7$	16.2	$1.8x10^6$	16.2	$19.0x10^6$	16.2	$22.0x10^6$	16.2	$26.0x10^6$	14.4
12	$2.6x10^6$	23.4	$6.8x10^6$	25.2	$7.6x10^6$	25.2	$8.3x10^6$	25.2	$9.0x10^7$	16.2	$9.4x10^7$	16.2	$9..5x10^7$	16.2	$9.9x10^7$	16.2	$7.0x10^7$	16.2	$14.8x10^7$	16.2	$21.5x10^7$	16.2	$23.0x10^7$	16.2
18	$2.3x10^7$	25.2	$4.1x10^7$	25.2	$5.2x10^7$	25.2	$6.7x10^7$	25.2	$4.2x10^8$	19.8	$6.2x10^8$	19.8	$6.3x10^8$	19.8	$6.5x10^8$	19.8	$3.4x10^8$	16.2	$7.9x10^8$	16.2	$8.8x10^8$	16.2	$11.3x10^8$	19.8
24	$6.0x10^7$	25.2	$7.5x10^7$	25.2	$8.4x10^7$	25.2	$9.2x10^7$	25.2	$1.8x10^9$	19.8	$3.9x10^9$	19.8	$9.6x10^9$	19.8	$9.8x10^9$	19.8	$1.6x10^9$	16.2	$2.3x10^9$	19.8	$2.5x10^9$	19.8	$2.7x10^9$	19.8

Table 3 . Effect of sodium metabislfite (SMBS) concentration on the growth and activity of *Saccharomyces cerevisiae, Zymomonas* (10988) and *Zymomonas* (29191) on culture media during 24 hours

Incupation T.(hr)	SMBS																					
	Saccharomyc serevislae								*Zymomonas* (10988)								Zymomonas (29191)							
	Blanck		0.001%		0.002%		0.003%		Blanck		0.001%		0.002%		0.003%		Blanck		0.001%		0.002%		0.003%	
	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %	T.C	Acidity %
0	$8.1x10^4$	23.4	$8.1x10^4$	23.4	$8.1x10^4$	23.4	$8.1x10^4$	23.4	$1.5x10^6$	14.4	$1.5x10^6$	14.4	$1.5x10^6$	14.4	$1.5x10^6$	14.4	$9.0x10^5$	14.4	$9.0x10^5$	14.4	$9.0x10^5$	14.4	$9.0x10^5$	14.4
6	$7.9x10^5$	23.4	$3.4x10^5$	23.4	$2.3x10^5$	23.4	$1.8x10^5$	23.4	$1.8x10^7$	14.4	$1.7x10^7$	14.4	$1.6x10^7$	14.4	$1.3x10^7$	14.4	$1.8x10^6$	16.2	$14.7x10^6$	14.4	$13.5x10^6$	14.4	$12.1x10^6$	14.4
12	$2.6x10^6$	23.4	$2.4x10^6$	25.2	$2.1x10^5$	25.2	$1.9x10^6$	25.2	$9.0x10^7$	16.2	$8.1x10^7$	16.2	$7.5x10^7$	16.2	$6.9x10^7$	14.4	$7.0x10^7$	16.2	$3.3x10^7$	14.4	$2.1x10^7$	14.4	$1.5x10^7$	14.4
18	$2.3x10^7$	25.2	$2.2x10^7$	25.2	$1.8x10^7$	25.2	$1.7x10^7$	25.2	$4.2x10^8$	19.8	$3.9x10^8$	16.2	$3.6x10^8$	16.2	$3.1x10^8$	16.2	$3.4x10^8$	16.2	$3.1x10^8$	16.2	$2.7x10^8$	16.2	$2.1x10^8$	16.2
24	$6.0x10^7$	25.2	$5.2x10^7$	25.2	$4.6x10^7$	25.2	$3.8x10^7$	25.2	$1.8x10^9$	19.8	$1.7x10^9$	16.2	$1.5x10^9$	16.2	$1.2x10^9$	16.2	$1.6x10^9$	16.2	$1.5x10^9$	16.2	$1.3x10^9$	16.2	$1.2x10^9$	16.2

Table 4. Effect of additives on total gas production by Fermentograph of dough leavened by yeast (Y), Zymomonas (Z) and their mixtur.

	Y	Z	Y:Z(3:1)	Y:Z (2:1)	Y:Z (1:1)	Y:Z (1:2)	Y:Z (1:3)
control	850	720	790	760	740	760	750
L.AA	940	820	920	840	820	760	800
SSL	930	810	900	830	820	810	840
SMBS	740	710	740	680	740	680	710

Table 5. Effect of different additives added to doughs leavened byYeast (y),*Zymomonas* (z) and their mixtures on total scores of pan bread.

	Control	L.AA(200ppm)	SSL(0.4%)	SMBS(0.002%)
Y	88.0	91.5	91.5	81.0
Z	81.5	83.0	81.5	74.0
Y:Z (3:1)	88.0	89.0	88.0	80.5
Y:Z (2:1)	88.0	88.5	87.0	79.5
Y:Z (1:1)	87.0	88.0	86.0	78.5
Y:Z (1:2)	85.5	87.0	85.0	77.5
Y:Z (1:3)	83.5	85.5	83.0	75.5
L.S.D.	0.90	0.87	0.83	0.75

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تأثير بعض الإضافات على المواد الرافعة وجودة العجين

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تناول هذا البحث دراسة تأثير بعض المواد المضافة مثل حمض الاسكوربيك ١٠٠، ٢٠٠، ٣٠٠ جزء فى المليون، صوديوم ستيرويل – ٢- لاكتيلات ٠,٢ ، ٠,٤ ، ٠,٦%و صوديوم ميتابيسلفيت ٠,٠٠١، ٠,٠٠٢، ٠,٠٠٣% على نمو خميرة الخباز وسلالتين من بكتيريا الزيموموناس فى بيئة النمو . كما تم دراسة سلوك كل من الخميرة والزيموموناس كل على حده أو مخلوطهم بنسب مختلفة (١:٣ ، ١:٢ ، ١:١ ، ٢:١ ، ٣:١ على الترتيب) فى وجود أو عدم وجود المواد المضافة فى العجينه أثناء تخمرها و كذلك جودة الخبز الناتج . وفيما يلى ملخص لأهم النتائج المتحصل عليها :

- أظهرت إضافة كل من حمض الاسكوربيك ، صوديوم ستيرويل لاكتيلات فى بيئة النمو تأثير محسن على نمو الخميرة وسلالتين من بكتيريا الزيموموناس ، وقد زاد هذا التأثير بزيادة تركيز هذه المواد المضافة .
- أدت إضافة صوديوم ميتابيسلفيت الى بيئة النمو الى تثبيط نمو كل من الخميرة والبكتيريا.
- وصل نمو خميرة الخباز إلى أقصاه عند إضافة حمض الاسكوربيك بنسبة ٣٠٠ جزء فى المليون ، وقد بلغت هذه الزيادة ١٧٠,٨ % اكثر من نموها بدون أى إضافات .
- كانت إضافة صوديوم ستيرويل لاكتيلات بنسبة ٠,٤% الى بيئة النمو هى الأحسن للحصول على نمو بكتيريا الزيموموناس بدرجة كبيرة حيث وصلت نسبة النمو الى ٤٣٣,٤ % اكثر من نموها بدون إضافات . وكانت هذه النتيجة مقاربة فى حالة استخدامها بتركيز ٠,٦ % .
- وقد أشارت النتائج أن بكتيريا الزيموموناس كانت منافس قوى لخميرة الخباز فى سرعة نموها و إنتاج الخلايا خاصة فى وجود صوديوم ستيرويل لاكتيلات والتى فاقت خميرة الخباز فى وجود حمض الاسكوربيك .
- أدت إضافة الخميرة بنسبة ١,٥ % إلى الحصول على أعلى زيادة لرفع العجينه مقارنة ببكتيريا الزيموموناس باستخدام جهاز الفرمنتوجراف.
- كلما زاد تركيز الخميرة فى مخلو طها مع الزيموموناس زاد إنتاج الغاز فى العجينة المخمرة ، وقد وصلت إلى أقصى حجم عندما كانت الخميرة موجودة بنسبة ٧٥ % فى المخلوط.
- إضافة حمض الاسكوربيك أو صوديوم ستيرويل لاكتيلات بتركيز ٢٠٠ جزء فى المليون و ٠,٤% على التوالى أدى الى تشجيع كل من الخميرة والبكتيريا ومخالطها لإنتاج غاز بكمية اكبر .

- إضافة حمض الاسكوربيك أو صوديوم ستيرويل لاكتيلات أدى إلى زيادة كمية الغاز الناتج بواسطة الخميرة وبكتيريا الزيموموناس ومخالطهم ، وخاصة عندما تكون نسبة الخلط بينهم (١:٣) ، وكمية الغاز الناتجة كانت قريبة من الناتجة بواسطة الخميرة بمفردها .
- إضافة صوديوم ميتابيسلفيت بتركيز ٠,٠٠٢ % أدى إلى نقص كمية الغاز الناتج فى العجائن المخمرة بواسطة الخميرة وبكتيريا الزيموموناس ومخالطهم .
- الخبز الناتج من العجائن المعاملة بحمض الاسكوربيك بتركيز ٢٠٠ جزء فى المليون وصوديوم ستيرويل لاكتيلات بتركيز ٠,٤% و ٠,٦% كانت خواصه الحسيه الخارجية والداخلية افضل خواص بينما إضافة صوديوم ميتابيسلفيت فى العجائن أدى إلى الإضرار بالخواص الحسية للخبز الناتج .
- استخدام بكتيريا الزيموموناس بمفردها فى رفع العجينة أدى حصول الخبز الناتج على قيمة تحكيم حسى اقل من الخبز الناتج بالخميرة فقط .
- عند خلط الخميرة مع بكتيريا الزيموموناس بنسبة ١:٣ ، ١:٢ لرفع العجينة فان الخبز الناتج حصل على قيمة تحكيم حسى مشابهة أو قريبة من الخبز الناتج بالخميرة فقط .
- كل مخاليط الخميرة مع بكتيريا الزيموموناس أعطت خبز ذات جودة حسية عالية عند إضافة صوديوم ستيرويل لاكتيلات بتركيز ٠,٤% مع وجود فرق بسيط بينهم .
- استخدام صوديوم ستيرويل لاكتيلات أدى الى تحسين شكل وتوزيع اللبابة للخبز الناتج يشبه فى ذلك الناتج من العجائن المخمرة بواسطة الخميرة ويشير ذلك الى الفعل التعاونى لمخلوط الخميرة وبكتيريا الزيموموناس وتفاعلهم مع صوديوم ستيرويل لاكتيلات .
- إضافة صوديوم ستيرويل لاكتيلات للعجينة المخمرة بواسطة بكتيريا الزيموموناس بمفردها أدى الى عدم وجود تحسين لقيمة التحكيم الحسى للخبز ولكنه حسن خواص اللبابة وإضافة حمض الاسكوربيك كان اكثر تأثيرا فى وجود بكتيريا الزيموموناس بمفردها فى العجينة .
- الخبز الناتج من إضافة صوديوم ميتابيسلفيت فى العجائن المخمرة بواسطة الرافعات موضع الدراسة ومخالطها كان له قيمة تحكيم حسى منخفضة بخاصة فى القصرة وخواص اللبابة والمجموع الكلى لقيمة التحكيم الحسى .

ومن ذلك يتضح أن :

- إمكانية استخدام بكتيريا الزيموموناس فى صناعة الخبز لتخمير عجائن دقيق القمح فى صورة مخاليط مع الخميرة بنسبة ١:٣ أو ١:٢ على التوالى مع إضافة صوديوم ستيرويل لاكتيلات بتركيز ٠,٤% مما يؤدى ذلك إلى زيادة أنواع منتجات المخابز لإرضاء الأذواق الخاصة لبعض المستهلكين .