MACEDONIAN MICROBIOLOGICAL SOCIETY
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CERTIFICATE

FOR ACTIVE PARTICIPATION WITH ORAL PRESENTATION

Ugur Gogus

A comparative study as related to the
effectes of various fumed and cured
tongue productions on some quality criteria
of beef tongue

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The Doctors Chamber of R. Macedonia has accredited this meeting for CME
(Continuing Medical Education)

President of the Organizing Committee
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President of the Scientific Committee
Doc. Dr Elena Trajkovska Dokic

4.7

ISOLATION AND CHARACTERIZATION OF POLYPHENOL OXIDASE AND PEROXIDASE PRODUCING BACILLUS STRAINS FROM FULLY FERMENTED TEA *(CAMELLIA SINENSIS)*

ИЗОЛАЦИЈА И КАРАКТЕРИСТИКИ НА POLYPHENOL OXIDASE И PEROXIDASE ПРОДУЦИРАЧКИ СОЕВИ НА BACILLUS ОД ПОТПОЛНО ФЕРМЕНТИРАН ЧАЈ *(CAMELLIA SINENSIS)*

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Tea (*Camellia sinensis*) is one of the most economically important crops and is considered to be the national drinks in many countries. Microbial population especially bacillus strains contain polyphenol oxidase and peroxidase increase during the fermentation process. Black tea is defined as complete form of fermentation of tea leaves and this form usually use by man. In this study sixteen aerobic endospore-forming bacilli, isolated from fully fermented tea in different tea processing factories and taxonomically characterized. The phenotypic characteristics, antibiotic susceptibility profiles, and fatty acids patterns were studied during the project.

Based on the obtained data (5 strains) belong to the species *B.subtilis*. Two strains, TB 2, and TB 4 were identified as *B.macquariensis*. Two isolate, TB 3, and TB 7 were identified as

B.pumilus. One strain TB 1 was belonged to *B. cereus*. Three strains, *Bacillus* TB 6, TB 9, and TB 14, showed antibiotic sensitivity profiles similar to *B.licheniformis*, but they had a distinct fatty acid composition and peculiar phenotypic traits. The taxonomic affiliation of *Bacillus* TB 5,TB 12, and TB 15 remained unclear because they were not resembled with none of these *Bacillus* strains. The fatty acid composition and antibiotic sensitivity of these three strains were different from the other 13 strains. Further taxonomic studies such as 16SrRNA gene-based phylogenic analysis is under investigation in order to determine the taxonomic affiliation of these three strain. The characterized strains were assayed for polyphenol oxidase and peroxidase activity. Amongst the isolated strains, TB 3, TB 7, TB 12, and TB 4 showed higher polyphenol oxidase activity than the other strains. The highest peroxidase activity was determined in TB 5, and TB 2 strains. These bacteria contribute in tea fermentation and may enhance the quality and flavor of tea.

4.8

A COMPARATIVE STUDY AS RELATED TO THE EFFECTS OF VARIOUS FUMED AND CURED TONGUE PRODUCTIONS ON SOME QUALITY CRITERIA OF BEEF TONGUE

КОМПАРАТИВНА СТУДИЈА ЗА ЕФЕКТИТЕ НА РАЗЛИЧНИ ПОСТАПКИ (ДИМЕЊЕ И КОНЗЕРВИРАЊЕ) ВО ПРОЦЕСОТ НА ПРОИЗВОДСТВО НА ГОВЕДСКИ ЈАЗИК И ВИЈАНИЕТО ВРЗ КВАЛИТЕТОТ

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Introduction: Various Fumed and Cured Tongue Production Methods are widely being used without no standard all over the world, using different bactericide and antioxidant. We still strongly need to determine the best Fumed and Cured Tongue production method, most enhancing microbial quality of the end product concerned and comparative effects of the antimicrobial agents in these productions. Followed by the division of 18-20 months old and ~ 1700g ±50 weighed beef tongues, they were processed with VFCTPM, including; 'Immersion(I)', 'Injection and Immersion(I+IM)', 'Immersion and Heat (IM+H)', 'Immersion, Heat and Peeling (IM+H+P)', 'Injection, Immersion and Heat (I+IM+H)', 'Injection, Immersion, Heat and Peeling (I+IM+H+P)'.

Aim: This study was carried out to compare the effects of Various Fumed and Cured Tongue Production Methods (VFCTPM) on some chemical, physical, bacterial and sensory quality criteria of the end product.

Material and Methods: Followed by the division of 18-20 months old and ~ 1700 g ±50 weighed beef tongues, they were processed with VFCTPM, including; 'Immersion (I)', 'Injection and Immersion (I+IM)', 'Immersion and Heat (IM+H)', 'Immersion, Heat and Peeling (IM+H+P)', 'Injection, Immersion and Heat (I+IM+H)', 'Injection, Immersion, Heat and Peeling (I+IM+H+P)

Results: Lower *Pseudomonas aureginosa*, Total Mesophile Aerob Bacteria(TMAB) counts and TBARS amounts of tongues, produced by 'I+IM+H' and 'IM+H', with their lower pH levels($p<0.01$), all through 12 weeks of shelf life under +7°C refrigerated condition, clearly indicate to the protective effect of the crust layer, which forms during heat application. This crust layer as a natural coating, covering all surface of the tongue, also underlines the importance of heat application, which should be combined with 'IM' or 'I+IM' applications during Fumed and Cured Tongue Production. The same crust layer, by decreasing water loss from meat surface and increasing bactericide and protective effect of NaCl, $NaNO_2$ and $NaNO_3$, might have been the main predisposed factor, leading to the higher L, a and b Hunter values, inspected in the same 'I+IM+H' and 'IM+H' production methods. The additional application of $C_6H_8O_6$ by injection, did not enhance bactericide effect, but caused lower mgMA/g TBARS amounts as naturally expected ($p<0.01$), whereas no significant difference was observed between 'I+IM+H', 'IM+H'.

A COMPARATIVE STUDY AS RELATED TO THE EFFECTS OF VARIOUS FUMED AND CURED TONGUE PRODUCTIONS ON SOME QUALITY CRITERIA OF BEEF TONGUE.

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ABSTRACT

This study was carried out to compare the effects of Various Fumed and Cured Tongue Production Methods(VFCTPM) on some chemical, phyhsical, bacterial and sensory quality criteria of the end product. Followed by the division of 18-20 months old and ~ 1700 g ±50 weighed beef tongues, they were processed with VFCTPM, inluding; 'Immersion(I)', 'Injection and Immersion(I+IM)', 'Immersion and Heat(IM+H)', 'Immersion, Heat and Peeling(IM+H+P)', 'Injection, Immersion and Heat(I+IM+H)', 'Injection, Immersion, Heat and Peeling(I+IM+H+P)'. Lower *Pseudomonas aureginosa*, Total Mesophile Aerob Bacteria(TMAB) counts and TBARS amounts of tongues, produced by 'I+IM+H' and 'IM+H', with their lower pH levels($p<0.01$), all through 12 weeks of shelf life under +7 °C refrigerated condition, clearly indicate to the protective effect of the crust layer, which forms during heat application. This crust layer as a natural coating, covering all surface of the tongue, also underlines the importance of heat application, which should be combined with 'IM' or 'I+IM' applications during Fumed and Cured Tongue Production. The same crust layer, by decreasing water loss from meat surface and increasing bacterisid and protective effect of NaCl, $NaNO_2$ and $NaNO_3$, might have been the main predisposed factor, leading to the higher L, a and b Hunter values, inspected in the same 'I+IM+H' and 'IM+H' production methods. The additional application of $C_6H_8O_6$ by injection, did not enhance bacterisid effect, but caused lower mgMA/g TBARS amounts as naturaly expected($p<0.01$), whereas no significant difference was observed between 'I+IM+H', 'IM+H'. Briefly, 'I+IM+H' and 'IM+H' production methods, can be strongly advised to the producer, as superior Fumed and Cured Tongue Production methods, leading higher microbial and physical quality, while minimizing contamination risk from surface by hands, with their crust layer, which should also and strongly be concerned from the point of customer health and food hygiene.

INTRODUCTION

Although Turkey is one of the leading countries in the world with its great livestock potential, it is not reflected to the amount of edible meat production. Owing to the problems in small scale based meat industry, it is ranked in the last level among the EC and EC-candidate countries. Another reason is proposed due preference of the traditional meat products by consumer attitude such as sausage, pastrami, roasted meat and salami rather than canned and patė style.

Up to date limited number of studies have been conducted on fumed and cured tongue, canned and paté meat products. Interestingly fumed and cured tongue has not only offer a delicate taste but also a high nutritional value is attained towards due product. Raw beef tongue is reported to be consisted of 75-80% water, 16-18% protein, 6% lipid, 1% mineral, and gives 3150 KJ / kg energy. It provides a great similarity in its composition to the raw beef meat (Sauci et al., 1986 / 1987).

In developing countries, fumed and cured tongue is said to be mostly consumed as delicates by the high level income group while raw tongue has a great demand among the poor. However, novel and low-cost production methodologies allow the fumed and cured tongue to be consumed by poor. Several methods are used worldwide to produce fumed and cured tongue. No standard method have been established on the production methodologies or comparing these methods. Only the maximum and minimum values for the quality criteria of the end product has been determined. Therefore under certain circumstances the producer and the consumer do not have any idea to select the most convenient production method and the end product. The main objective of the study is to compare the different production methods of the cured and the fumed tongue in light of the quality criteria of the refrigerated(÷ 4° C) end product.

MATERIALS AND METHOD

Thirty-six beef tongues, of the same age(18-20 months old) and same weight were purchased from a local market and immediately transported to the laboratory to prevent spoilage. The tongues were immersed and incubated in cold tap water(5 °C) at room temperature for 12 hours. Unwanted particles like feed, expectorates, fat and connective tissue were aseptically removed by using a tough brush. After cleaning, brushing and rinsing, the tongues were kept as refrigerated at +2° C for 24 hours in accordance to the VFCTPM standards.

Immersion(IM)

A homogeneous pickle solution was prepared by dissolving 1.2 kg NaCl, 18 g $NaNO_2$, and 18 g $NaNO_3$ in 12 L tap water. Six beef tongues were placed in three of 6-L containers as two tongues in each container in 4 L pickle solutions and left for incubation for five days at 4± 1° C. At the end of this period the tongues were inverted and the maturation was continued for another three days (Gerrard, 1976).

Injection prior to immersion(I + IM)

66 g sodium ascorbate was added into 12 L pickle solution prepared above. After a subsequent thoroughly mixing process, 10% of the weight of the tongue was approximately obtained from this solution and half of it was injected into the sublingual artery (V. sublingualis) by means of a sterile 10 mL syringe(Gerrard, F. 1976). Consequently these six injected tongues were moved into 6 L containers in dual and were completely covered by 4 L pickle solution and left under incubation conditions for three days at 4± 1° C.

Immersion and heat application(IM + H)

Heat application(scalding) was carried out on six tongues after a maturation period of eight days in the same pickle solution mentioned within immersion technique (Long et al., 1981). The scalding process involves the placement of the tongues in an aluminium cooker in 25 L water at **boiling** point per 2,5 kg tongue for three hours, valid for each method mentioned through the study.

Immersion, heat application and peeling (IM + H + P)

Another group of six tongues treated likely as in immersion and heat application method, was further subjected to a manual skin removal process by using sterile gloves (Gerrard,1976).

Injection, immersion and heat application(I+ IM + H)

Heat application was performed on six tongues after a maturation process, carried out for three days, following a prior treatment of I + IM(Long et al., 1981).

Injection, immersion, heat application and peeling (I+ IM + H + P)

After the application of the combinational method of I+ IM + H, peeling was conducted on six beef tongues (Long et al., 1981).

Smoking process

Totally 36 beef tongues, prepared according to all of the methods above, were exposed to smoke, as being hanged over the smoking bars for 70 minutes at 60° C while the damper was left open. The temperature was subsequently elevated up to 83° C and the dried tongue were kept at this temperature for five hours. After completion of smoking, the tongues were

packed in aluminium foil, coded and kept at + 7° C. The chemical, physical, bacterial and organoleptic analyses were carried out at the eighth day after storage at + 7° C. Bacterial analysis were repeated at the 10^{th} and the 12^{th} days.

Chemical analysis

Specimens for chemical and bacterial analysis were made by cutting the slices from the corpus palatinae's highest point. 7 g from the center(not from the crust) of the slice, was used for the concerned chemical and microbial analysis. 7 g cuts from each of 6 tongues belong to in VFCTPM were groung and mixed homogenously and used in all analysis.

Determination of water content, crude protein and crude lipid amounts

These analyses were carried out according to the methods described by Lees, 1975. 5 g of specimens for all chemical and 1 g of specimens for all bacterial analysis were used.

Determination of Nitrite Residues

Nitrite residues of the samples were detected by the reference methods described by the standards of ISO, 1978.

Detection of pH levels

The pH values of the solutions used in the whole experiment were detected by a Heidolph-Schott Mainz digital pH meter (Lees, 1975).

Determination of TBARS (2-thiobarbutiric acid)

The amount of 2-thiobarbutiric acid reactive substances were detected according to the method of Tarladgis et al.(1960).

Physical analysis

Color determination

Color was determined by Hunter method, described by Bradford et al.,1993 L(brightness) red / green (±a), yellow / blue(±b) values were determined by using Shimadzu UV 2100 model recording spectrophotometer.

Bacterial Analysis

Total mesophilic aerobic bacteria(TMAB) and *Pseudomonas* spp.. counts;

1 g from ground and mixed specimens which was prepared as mentioned above, was diluted up to 10^{-8} in sterile dilution medium, containing 0.1% peptone(SIGMA)(Harrigan and Mc Cance, 1976). Using Plate Count Agar (PCA) (Oxoid) for Mesophilic Aerobic Bacteria (MAB) and Mac Conkey Agar (Oxoid) for *Pseudomonas* counts carried out enumeration. Spread plating for *Pseudomonas* and Pour plating for Mesophile Aerobe Bacteria at 37 °C for 24-48h as in triplicates, were carried out for each dilution.

Statistical Analysis

Analysis of Variance (ANOVA) and Anova Duncan Range test, described by Scheffe (1970) were applied to determine the differences among VFCTPM and to be informed about the degree of freedom of these differences.

Organoleptic Analysis

A taste panel, consisting of 20 persons of different occupation, age, sex and region was applied to be informed about certain organoleptic quality criteria of the end products produced according to VFCTPM. Each panelist evaluated the selected fumed and cured tongues belonging to the six application group, on the basis of rating between ''1'' (the worst) and ''10'' (the best). All sensory assessments were performed under natural light. Natural spring water was provided between samples to cleanse the palate. The evaluation was performed due scores to detect the better ones.

RESULTS AND DISCUSSION

Water contents of the tongues were shown in Figure 1. A maximum water content, as 61.02% and a minimum value of 41.16 % were achieved in treatments of 'IM' and 'I+IM+H+P', respectively. The lowest water losses were detected in 'IM', and 'I+IM', while the highest water losses were belong to the 'I+IM+H+P' and 'IM+H+P' applications($p<0.01$). The fuming and the additional heating (boiling) of the tongue batches belong to the 'I+IM+H+P' and 'IM+H+P' production methods, may have caused more water losses during storage, as naturally expected.

The crude lipid contents demonstrated an interval of 14.55% and 19.48%. The effect of VFCTP methods on crude lipid contents was found to be significantly important($p<0.01$). The results of Duncan Range test implied that' IM' and 'I+IM' caused the lowest losses. Higher decreases were observed in 'I+IM+H+P' and 'IM+H+P' methods, which may be due to the effects of heating during fuming and additionally boiling applications of these methods.

The crude protein content ranged between 17.08 % and 19.48 %. The highest crude protein content was belong to 'I+IM' with 19.18%, while the lowest crude protein content was belong to 'IM+H+P' with 17.08%. VFCTPM have a significant effect on the crude protein content of the fumed and cured beef tongues($p<0.01$). 'I+IM' and 'IM' were the two methods, which caused to the the lowest crude protein losses($p<0.01$), followed by 'IM+H', 'IM+H+P'. 'I+IM+P' and 'I+IM+H' were the two methods, leading to the highest protein losses during refrigerated storage($p<0.01$) .

VFCTPM have significant effects on "a" (red/green) Hunter color criteria($p<0.01$)(Fig. 4). The most dominant "a" color values, were detected in tongues which were produced by 'IM+H' followed by 'I+IM+H' and 'I+IM' production methods. VFCTPM have also great effect on "b" (yellow/blue) Hunter color criteria($p<0.01$)(Fig. 5). This effect is similar to the effects of these production mthods on "a" Hunter values. The most dominant "b" color criteria, in other words, the most yellow tone preservation and domination of yellow to the blue, was detected in tongues 'IM+H' and 'I+IM+H', followed by 'I+IM+H+P', 'IM+H+P' and 'I+IM'($p<0.01$).

The lowest brightness loss which are referred by "L" Hunter value, was observed in the tongues, which were produced by 'I+IM+H+P' and 'I+IM+H' production methods, followed by 'IM', 'IM+H' and 'IM+H+P'($p<0.01$, Fig. 6).

When all "a" and "b" Hunter color criteria are taken into the consideration, it can be clearly expressed that, both a and b values are higher in 'IM+H' and 'I+IM+H' production methods. In both productions, the crust layer on the surface of the tongues, which are produced by fuming and additional heating(boiling)applications, were not peeled. The tongues which have crust layers, were produced by only these two methods; 'IM+H' and 'I+IM+H'. The same crust layer, covering all surface of the tongues, belong to these two methods, may be the main reason for the highest "a" and "b" values of the tongues, which were produced by the same

methods. In spite of it's durability, nitric oxide haemochromogen pigment, can also be degraded by bacterial and enzymatic acivity(Pearson and Tauber, 1984), during refrigerated store of fumed and cured tongues. The crust layer which covers the surfaces of the tongues, belong to 'IM+H' and 'I+IM+H' methods, is also a predisposed factor, leading to the lowest TMAB and *Pseudomonas* counts and, in other words, higher microbial quality in these methods with lower acidity losses (Fig. 2, 3 and 8), when compared with the others. This protective effect of the same crust layer againts bacterial entrance to the tongue from surface, may have created the higher "a" and "b" values belong to the same methods. These lower TMAB and *Pseudomonas* counts with the higher "a" and "b" values in the same tongues which have crust layer clearly indicates to the microbial quality increasing and therefore color quality increasing effects of 'IM+H' and 'I+IM+H' production methods.

The lowest nitrit residue losses were detected in again 'IM+H' and 'I+IM+H', followed by 'IM', 'I+IM+H+P'($p<0.01$)(Fig. 9). Nitrat and nitric oxide haemochromogen pigment, as mentioned above, can be degraded by the time by bacterial and enzymatic activity during storage. Therefore, the crust layer which was produced by the effect of fuming and heating applications in 'IM+H' and 'I+IM+H', may have created lowest nitrit losses by protecting the tongues against microbial entrance from tongue surface, which also may have leaded to the nitrit and nitric oxide haemochromogen preservation. 'IM+H' and 'I+IM+H' are not only the fumed and cured tongue production methods, leading higher microbial quality from the point of *Pseudomonas* spp. and TMAB, but also the same methods were determined as the methods which created the lowest acidity losses and the lowest TBARS(2-Thiobarbutiric acid reactive substances)amounts during storage($p<0.01$, Fig.3 and Fig 7), which also confirms the better microbial and color quality, observed in the same two methods.

When sensory quality criteria of VFCTPM are compared, there is no significantly important effect of them on toughness and taste, while they significantly effects the odor, color, texture and appearance($p<0.01$). 'I+IM' and 'I+IM+H' were again the two methods, having got a higher rate of acceptability from the point of appearance, while 'I+IM+H' from the point of texture, 'I+IM', 'IM+H' from the point of color, and 'I+IM+H' from the point of odor, were the superior methods($p<0.01$). The higher rate of acceptance from the taste panellists are also confirmed by the higher a, b and L Hunter values and even lower TMAB and *Pseudomonas* spp. counts with lower pH levels(Fig. 3) in these both groups. We strongly believe in the close relation among lower *Pseudomonas* and TMAB counts or higher microbial quality, higher

nitrit residue and lower TBARS amounts and lower pH levels in 'IM+H' and 'I+IM+H'. The lower bacterial counts of these groups are the main predisposed factor leading lower pH levels and TBARS amounts. The lower bacterial counts and lower pH levels of the same methods also lead to the lower nitrit residue losses by protecting the nitrit residue and nitric oxide haemochromogen from bacterial degradation. Therefore and just because of this close relation, appearance and color sensory of the taste panel, were also appeared as in higher acceptability for 'IM+H' and 'I+IM+H' production methods.

CONCLUSION

When all comparative analyse results belong to VFCTPM are concerned, 'IM' and 'I+IM' methods were the ones having got higher water, crude protein and lipid amounts, presumably there is no boiling application in these production methods. On the other hand, the tongues which were produced by 'I+IM+H' and 'IM+H' applications had higher microbial, Hunter, acidity and sensory quality criteria because of the protective effect of these tongue crust layers. These higher quality criteria of the same batches, were also confirmed by the lower TBARS and higher nitrit residue amounts, belong to the same tongues. The fumed and cured tongues are being sold in most of the European countries and also Turkey, by peeling the crust layer manually prior to selling. Unfortunately, during this peeling process, the poor microbial quality of personnel and their hands, also elimination of the protective potency of the crust layer by peeling it, can easily and significantly lower the microbial quality of these products during marketing and storage. Therefore, the data which are discussed and mentioned above, points two important results. 'I+IM+H' and 'IM+H' cured and fumed tongue production methods are the two superior methods among others, leading higher microbial and sensory quality, which can also be strongly advised to producer. But more important is, the necessity of the crust layer existence, since it acts strongly as a microbial enhancer as a natural coating. That is why it should never be peeled from the tongues which are belong to 'I+IM+H' and 'IM+H' methods, by personnel manually. The preference of the crusty tongues by markets, producers and customers, which are produced by 'I+IM+H' and 'IM+H' cured and fumed tongue production methods, will not only increase the microbial and sensory quality, but will also be able to protect the end product from hand to tongue and bench to tongue cross contaminations, since it acts as a strongly effective natural coating.

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FIGURES

1. Water contents (g/100g) of fumed and cured tongues which were produced by various fumed and cured tongue production methods.
2. TMAB amounts of fumed and cured tongues which were produced by various fumed and cured tongue production methods.
3. pH levels which belong to fumed and cured tongues which were produced by various fumed and cured tongue production methods.
4. 'a'(red/green) Hunter values which belong to fumed and cured tongues which were produced by various fumed and cured tongue production methods.
5. 'b'(yellow/blue) Hunter values which belong to fumed and cured tongues which were produced by various fumed and cured tongue production methods.
6. L(brightness) Hunter values which belong to fumed and cured tongues which were produced by various fumed and cured tongue production methods.
7. TBARS(2-thiobarbituric acid values) which are belong to fumed and cured tongues which were produced by various fumed and cured tongue production methods.
8. Total *Pseudomonas* spp. amounts of the tongues which were produced by various fumed and cured production methods.
9. Nitrit residue levels of the tongues which are belong to various fumed and cured production methods during refrigerated storage.

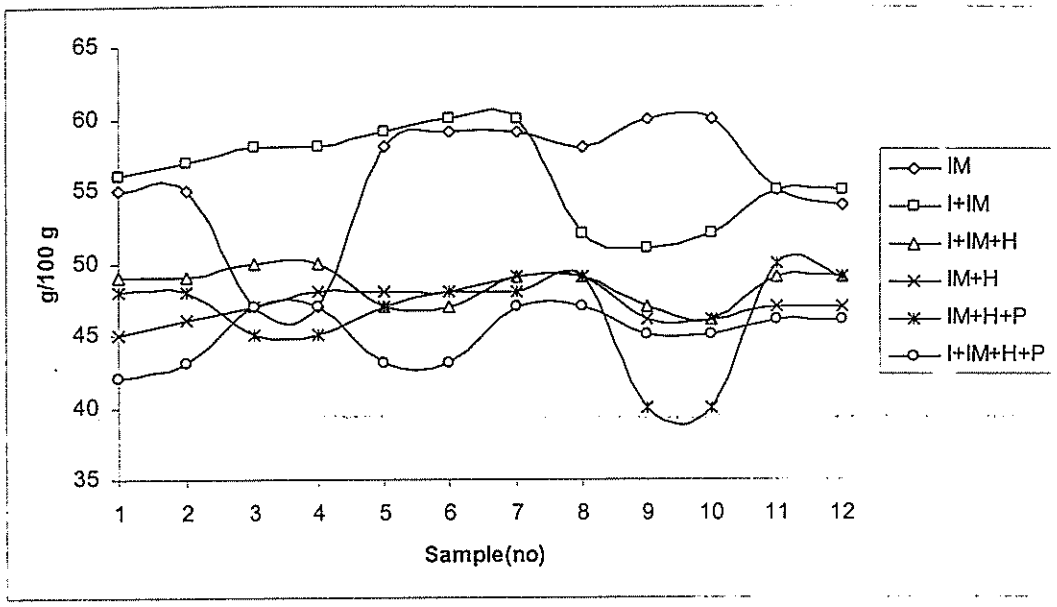

65
60
55
50
45
40
35
g/100 g
1
2
3
4
5
6
7
8
9
10
11
12
Sample(no)
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 1

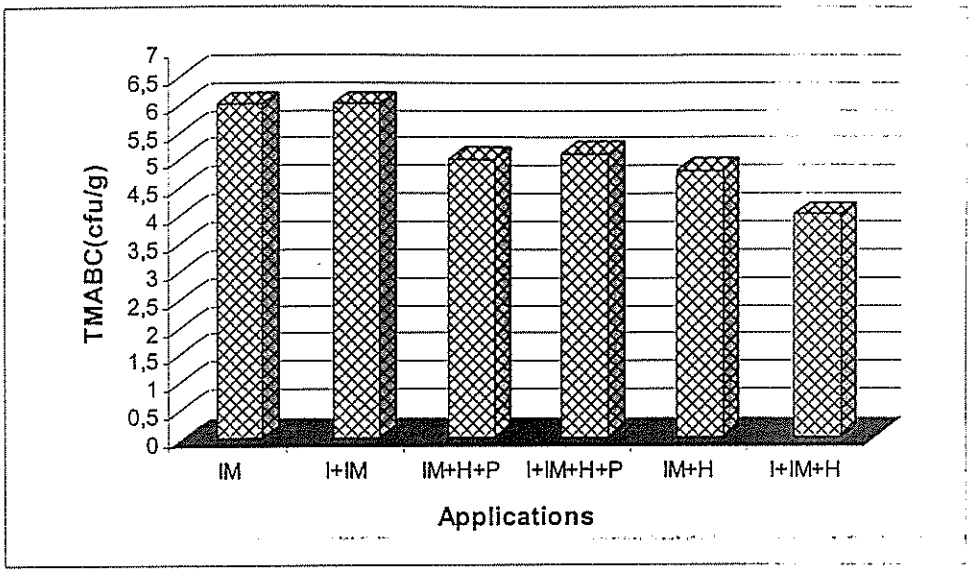

TMABC(cfu/g)
7
6,5
6
5,5
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
IM
I+IM
IM+H+P
I+IM+H+P
IM+H
I+IM+H
Applications

Fig. 2

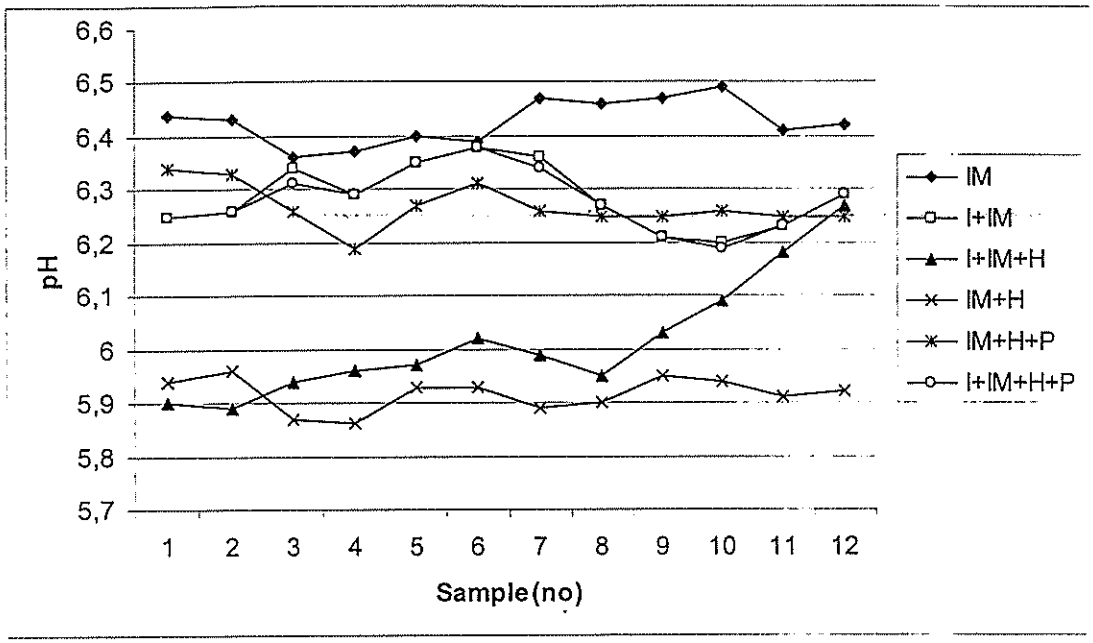

6,6
6,5
6,4
6,3
6,2
6,1
6
5,9
5,8
5,7
pH
1
2
3
4
5
6
7
8
9
10
11
12
Sample(no)
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 3

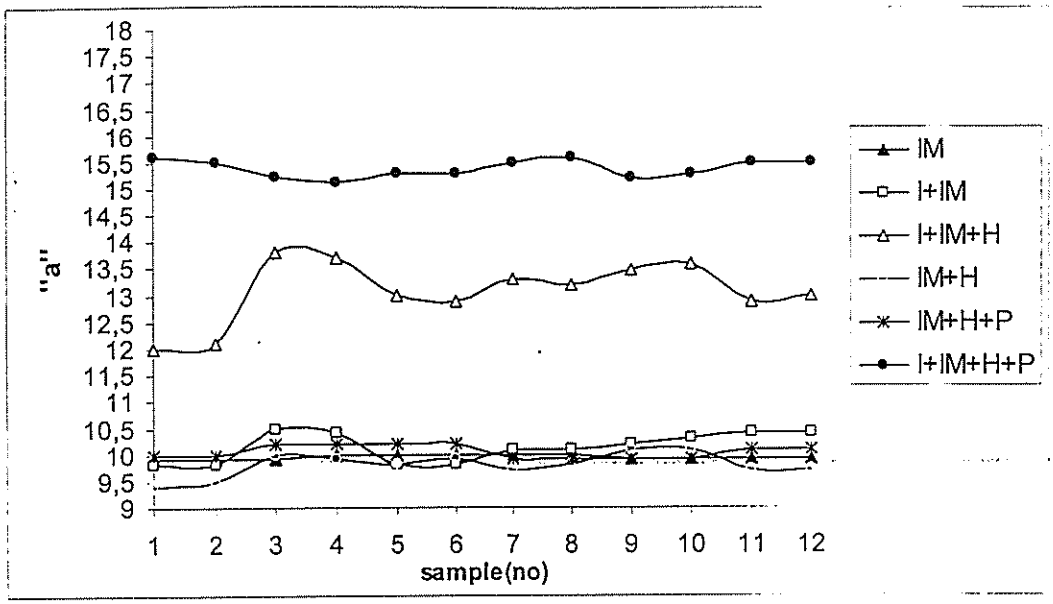

18
17,5
17
16,5
16
15,5
15
14,5
14
13,5
13
12,5
12
11,5
11
10,5
10
9,5
9
"a"
1
2
3
4
5
6
7
8
9
10
11
12
sample(no)
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 4

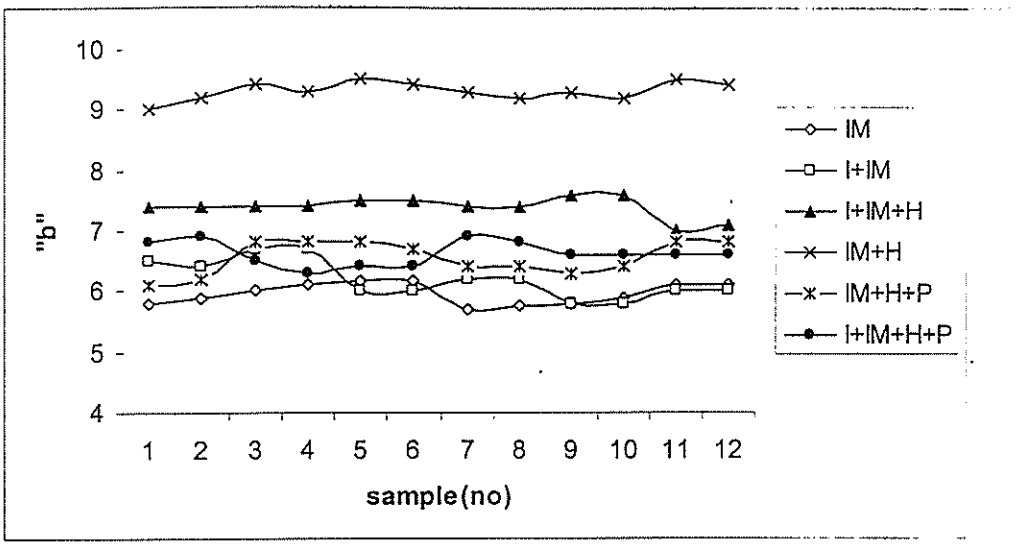

10
9
8
7
6
5
4
"b"
1 2 3 4 5 6 7 8 9 10 11 12
sample(no)
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 5

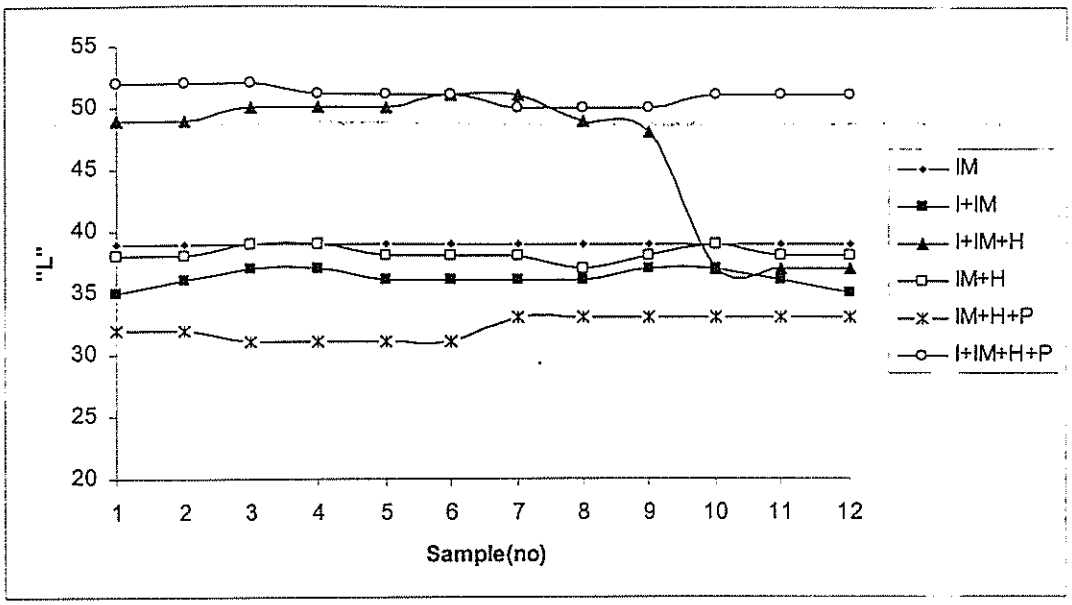

55
50
45
40
35
30
25
20
L*
1
2
3
4
5
6
7
8
9
10
11
12
Sample(no)
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 6

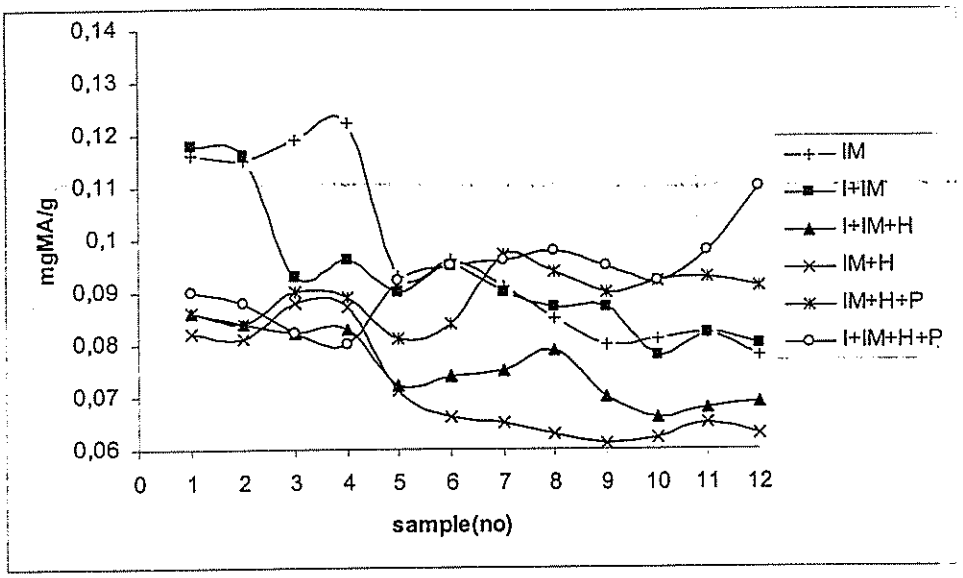

0,14
0,13
0,12
0,11
0,1
0,09
0,08
0,07
0,06
mgMA/g
0
1
2
3
4
5
6
7
8
9
10
11
12
sample(no)
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 7

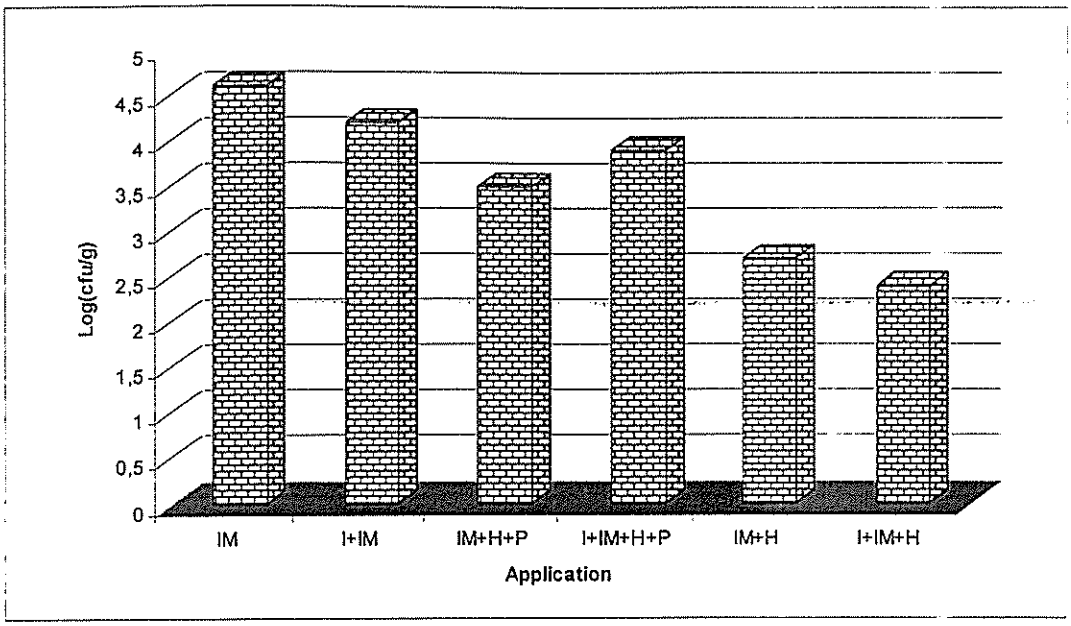

5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
Log(cfu/g)
IM
I+IM
IM+H+P
I+IM+H+P
IM+H
I+IM+H
Application

Fig. 8

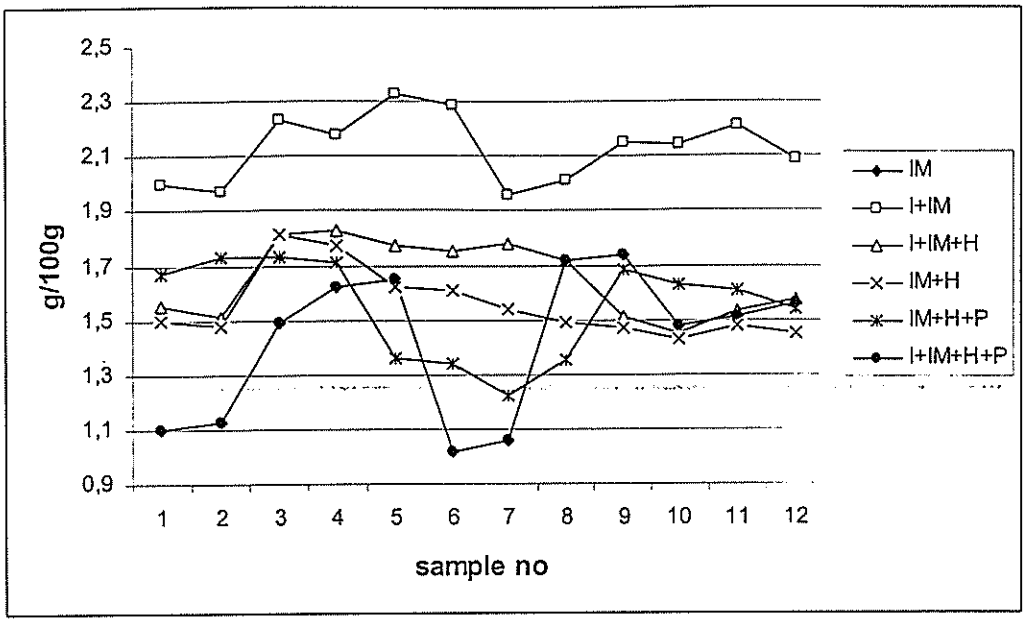

2,5
2,3
2,1
1,9
1,7
1,5
1,3
1,1
0,9
g/100g
1
2
3
4
5
6
7
8
9
10
11
12
sample no
IM
I+IM
I+IM+H
IM+H
IM+H+P
I+IM+H+P

Fig. 9