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# EFFECT OF IODIZED SALT ON SOME PATHOGENIC AND NON-PATHOGENIC MICROORGANISMS AND ITS APPLICATION IN PROCESSED FISH AND PICKLES QUALITY

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## ABSTRACT

The present study was carried out to investigate the effect of iodized salt and unfortified salt (NaCl) on some pathogenic and non-pathogenic microbes (*Staphylococcus aureus, Listeria monocytogenes, Aspergillus flavus, Bacillus subtilis* and *Saccharomyces cerevisiae*) in selective media. The effect of low level and high level of iodized salt were evaluated using disc paper technique as minimum inhibition concentrate (MIC). Data revealed that effect of iodized salt was higher on pathogenic than non-pathogenic microbes, the effect was increased with increasing the concentration of iodized salt. Heavy metals (Co, Cu, Pb, Zn and Fe) which lead to a real harmful effect on consumers were determined to discrimination between the sources of iodized salts. Also, identification the component of iodized salts using thin layer chromatography (TLC) to determine $R_f$ value and color under UV light (365 nm) by two developing systems.

On the other hand the application of iodized salts were done (at 4000 and 5000 ppm Iodine) in processing of wet salted fish and pickled cucumber. Total viable counts were determined during storage periods, which slightly increased with prolonged storage. Also, sensory characteristics (color, taste, odor and acceptability) were done for all tested samples et the end of storage period. Statistical analyses revealed that no significant differences were detected between the tested samples. So, it could be recommended to use iodized salt in food processing to improve microbiological, sensory quality and protect consumers health.

## INTRODUCTION

Common edible salt has an important role as food additive in preparation and processing of food products. Its function includes one or more of the following aspects: flavoring, preservation, formation of a desirable texture by solubilization of food proteins, controlling the rate of fermentation and reduction of water absorption in bread and bakery products (Crocco, 1982 and Schmidt 1988).

Iodine is an essential trace element for mammalian development because it is a constituent of the thyroid hormones, thyroxin and triiodothyronine (Hetzel, *et al.*, 1990).

Previous studies have shown that a safe daily intake of iodine has been estimated to be between 50 and 1000 µg/day (Stanbury and Hetzel 1980 and WHO, 1991).

Iodine deficiency not only causes goiter but it may also result in irreversible brain damage in the fetus and infant (WHO, 1994).

Cretinism in childhood is a well-known manifestation of iodine deficiency (WHO, 1995).

Loncarevic, *et al.* (1996) found that *Listeria monocytogenes* was isolated from fish samples. Ten of 16 positive samples harbored more than 100 cfu/g *Listeria monocytogenes*.

Azanza, *et al.* (1998) found that no significant differences were detected between the physicochemical, microbiological and sensory characteristics of the test products with iodized and unfortified NaCl salts. They recommended the addition of iodine to semi-processed or completely processed food products to lessen iodine losses.

Zidan, *et al.* (1998) reported that food grade salt should be free from contaminants that may be harmful to the consumer health. In particular the following maximum limits recommended by Codex Alimentarius (1991) should not be exceeded in the produced NaCl: Cu (2.0), Pb (2.0), Cd (0.5) and Hg (0.1) mg/kg. While, the Egyptian standard specifications of the edible sodium chloride (1996) indicated that the following maximum limits should not be exceeded: Fe (10.0), Cu (2.0) and Pb (2.0) ppm, respectively.

Ibrahim *et al.* (2001) found that the concentration of Copper Cu (4.0 ppm), Lead (Pb, 20 ppm), Iron (Fe, 13 ppm) mercury (Hg) that reached (1.0 ppm) and Zinc, (Zn, 5.0 ppm) in El-Sayahaat salt. While, Fe, Cu, Pb, and Zn were, (4.90, 1.70), (0.17, 1.20), (0.12, 0.18) and (14.0, 17.0) ppm in imported source of NaCl samples from Jordan and Saudi Arabia, respectively.

The present work has been devoted to study the heavy metals that may be presented in the edible table salt (NaCl) and salt fortified with iodine (iodized salt), its effect on some pathogenic and non-pathogenic microorganisms, focuses to ability application of iodized salt in pickles, salting cured fish processing and its quality.

## MATERIALS AND METHODS

**Materials:-**

**A) Salt NaCl (Sodium Chloride):**

Standard salt (NaCl) free from iodine was obtained from company and the chemical product, Egypt (June, 2001).

Iodized table salts used in this study were obtained from local super market (Zagazig City, Sharkia, Egypt) as the following:-

1- El-Arossa salt was contained potassium iodide (30 – 70 ppm) + NaCl, it obtained from El-Naser company Zefta for salt product, Egypt January 2002.
2- Safi salt was contained potassium iodide from (30 – 70 ppm) + NaCl, it obtained from El-Naser company for salting by El-Motaheda company, Egypt, February 2002.
3- Sasa salt was contained potassium iodide from (30 – 70 ppm) + NaCl, it obtained from Saudi Arabia, December 2001.
4- Masa salt was contained potassium iodide from (30 – 70 ppm) + NaCl, it obtained from Saudi Arabia, December 2001.

**B) Cucumber samples:**

The cucumber fruits (*Cucumber staves*, L.) samples at optimum stage of maturity used in this study were obtained from Zagazig City, Egypt.

**Preparation of cucumber samples:**

1- Cucumber (5 Kg.) were washed with tap water to remove dirt and soil particles and damage fruits.
2- After washing, Cucumber sliced (7 cm in length and 5 mm thickness).
3- *Sliced cucumber cover with brine solution* wet salting method in glass jars container 250 gm the following salt concentration for pickling treatment were:-
   NaCl 15% as control.
   NaCl 15% + 4000 ppm iodine.
   NaCl 15% + 5000 ppm iodine.
   NaCl 20% as control.
   NaCl 20% + 4000 ppm iodine
   NaCl 20% + 5000 ppm iodine.
4- *All treatments as two trials of glass jars* closed and the fermentation as natural according to Kolesnikov (1985) was carried out at a constant ambient temperature at about 25 – 28°C and analysis of samples during storage periods (0, 5, 10 and 15 days) for microbiological test and sensory evaluation after 15 days.

**C) Sardine Fish processing as the following:**

Sardine (*Sardinella* sp.) fish (5 Kg.) were obtained from locally market. Fish samples were then washed with tape water. Head, tail, fins and viscera, of the fish were removed and discarded, fish flesh washed by tape water and sliced into transverse slices fillets (as mentioned by El-Shawaf 2000). All samples put in glass jars container and covered with brin solution as above treatment using 4000, 5000 ppm iodine as additive to salt NaCl (15% and 20%). Cured fish samples stored at room temperature until determination microbiological test after (0, 5, 10 and 15 days) and sensory evaluation, carried out at the end of fermentation (15 days).

**Methods:-**

**Heavy metals:**

*Heavy metals (Cobalt Co, Copper Cu, Zink Zn, Lead Pb and Iron Fe) of* salt samples were determined using Unicom 969 AA spectrometer SOLAAR Atomic Absorption, Central Laboratory, Fac. of Agric., Zagazig Univ., Egypt, according to Luten *et al.* (1986).

**Microorganisms:**

*Staphylococcus aureus*, and *Listeria monocytogenes* were obtained from Dairy Dept., Fac. of Agric., Mansoura Univ., Egypt.

*Aspergillus flavus*, *Bacillus subtilis* and *Saccharomyces cerevisiae* were obtained from Dept. of Microbial., Fac. of Agric., Mansoura Univ., Egypt.

**Microbiological analysis:**

*Staphylococcus aureus*: plated with staphylococcus medium No. 110 (Difco, 1974).

*Listeria monocytogenes*: plated with NAB (Nalidixicacid blood) agar medium according to (Beerens and Tahon-Castel, 1966).

*Aspergillus flavus*: Potato dextros agar (PDA) was used according to Adekunl and Ayeni (1974).

*Bacillus subtilis*: Nurient agar medium was used.

*Saccharomyces cerevisiae*: Using nutrient agar medium.

**Antimicrobial activity:**

Iodized table salt samples were added at 0, 100, 200, 300, 400, 500, 1000, 2000, 3000, 4000 and 5000 ppm to determine its effect on pathogenic and non-pathogenic microorganisms using minimum inhibition concentration (MIC) paper disc (5 mm) method during their growth at 30°C for 48 hrs and 5 days for fungi. The sensitivity of each microbe for the different concentrate was recorded as mentioned by El-Shawaf and Gomaa (2000) as follows: Zones diameter > 15 mm highly sensitive, 5 – 15 mm moderate sensitive, 1 – 5 mm slightly sensitive and no zone considered to be insensitive.

**Total viable counts (TVC):**

The pour plate technique for the microbiological analysis. Plate counts were performed on nitrient agar for pickles and fermented fish medium according to American Public Health Association (APHA) (1960). After serial dilutions and inoculation, plates were incubated at 30°C for 48 hours before counting. The average of triplicate reading were taken as mentioned by El-Kotry, *et al.* (1994).

**Thin layer chromatograph (TLC):**

Slain solution of table salt NaCl with and without iodine were spotted on TLC silica gel G plates and using two solvent system:-

A (Ethanol: Ethyl acetate: water) (v / v)

50 : 30 : 20

B (Ethyl acetate : Acetic acid : water) (v / v)

80 : 30 : 20

Also, potassium iodied and iodine were spotted on TLC too. The examination under ultra violet UV lamp (365 nm) with fresh starch solution (1%) as spray agent was carried out and the components were marked for $R_f$ value.

$$\text{Were } R_f \text{ value} = \frac{\text{Distance of samples}}{\text{Distance of solvent}} \text{ on TLC.}$$

**Sensory evaluation:**

Sensory evaluation for all investigated samples of pickles and cured fish were evaluated by a taste panel of 10 well trained members. The samples were tested for color, odor, taste and acceptability as mentioned by El-Sherbiny (1996).

**Statistical analysis:**

Collected data were subjected to analysis by the technique of analysis of variance (ANOVA) as mentioned by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

Data in Table (1) revealed that the high effect on *Staphylococcus aureus* as pathogenic microb was iodized salt (Safi salt) for inhibition on the growth. While, iodized salt (Sasa salt), iodized table salt (Arossa salt) and iodized table salt (Masa salt) for inhibitor agent on the growth of pathogenic bacteria, respectively. Also, results in Table (1) showed that the effect of *iodized table salt (Safi salt) was high effect on the growth of Listeria monocytogenes* than both Sasa, Arossa and Masa table salt, compared with control no fortified with iodine, respectively.

**Table (1): Effect of market iodized salt at different concentration on some pathogenic and non-pathogenic microbes compared with control.**

| Type of microorganisms | Concent-ration (%) | Type of iodized salt samples | | | | |
|---|---|---|---|---|---|---|
| | | 1* | 2 | 3 | 4 | 5 |
| *Staphylococcus aureus* | 0 | - | - | - | - | - |
| | 2 | - | - | + | + | - |
| | 5 | - | - | + | - | - |
| | 10 | - | - | - | + | - |
| | 15 | - | - | + | - | - |
| | 20 | - | ++ | - | - | ++ |
| *Listeria monocytogenes* | 0 | - | - | - | - | - |
| | 2 | - | - | + | - | - |
| | 5 | - | - | + | - | - |
| | 10 | - | - | + | - | - |
| | 15 | - | - | + | - | - |
| | 20 | - | - | ++ | ++ | - |
| *Aspergillus flavus* | 0 | - | - | - | - | - |
| | 2 | - | - | - | - | - |
| | 5 | - | - | - | - | - |
| | 10 | - | - | + | - | - |
| | 15 | - | - | - | - | + |
| | 20 | - | - | ++ | - | - |
| *Bacillus subtilis* | 0 | - | - | - | - | - |
| | 2 | - | - | - | + | + |
| | 5 | - | - | + | - | - |
| | 10 | - | - | + | + | + |
| | 15 | - | - | - | - | + |
| | 20 | - | - | - | ++ | ++ |
| *Saccharomyces cerevisiae* | 0 | - | - | - | - | - |
| | 2 | - | - | + | - | + |
| | 5 | - | - | - | + | + |
| | 10 | - | - | - | + | - |
| | 15 | - | - | + | + | - |
| | 20 | + | - | + | ++ | - |

*1- NaCl pure and free from iodine. 2- Arossa salt
3- Safi salt 4- Sasa salt 5- Masa salt
Nil: Insensitive ( - )
+: Slightly sensitive (1–5 mm) ++: Moderate sensitive (5–10 mm).

Data in the same Table illustrated that *Aspergillus flavus* (toxic) inhibited by both iodized table Safi salt than Masa salt and there is no effect of both Arossa salt, Sasa salt and Control treatment.

Also, results in the above Table (1) showed that there is no effect for control sample and Arossa salt on both *Bacillus subtilis* and *Saccharomyces cerevisiae* compared with Masa salt, Sasa salt and Safi salt which have high effect respectively. Finally, iodized salt Safi salt have high effect on pathogenic microorganisms than other iodized salt and control treatment, this may be due to the varied effect of iodine as antimicrobial and NaCl as preservative agent on the microbial growth.

Data in Table (2) show the identification of component of iodized table salt on TLC under ultra violet light at 365 nm using two solvent systems. The results illustrated that pure salt contain one compound at $R_f$ 0.851 and 0.108 for solvent A and B respectively. While, iodized table salt contain one compound at $R_f$ 0.860 – 0.102 for Safi salt, $R_f$ 0.858 – 0.110 for Sasa salt, $R_f$ (0.857 – 0.110) and blue color for all compound using solvent A and B respectively. While, $R_f$ for iodine and potassium iodide (0.919 – 0.805) and (0.832 – 0.635) using solvent A and B with high blue color, respectively.

The different variation in $R_f$ for all samples of iodized salt and control may be due to the purity of table salt and some heavy metals found in the mixture of table salt.

**Table (2): Identification of component in iodized salt on thin layer chromatography (TLC) under UV lamp at (365 nm).**

| Type of salt samples, iodine and potassium iodide | Type of component with two solvent system | | | |
|---|---|---|---|---|
| | Solvent (A) | | Solvent (B) | |
| | Color | $R_f$ | Color | $R_f$ |
| Pure salt | - | 0.851 | - | 0.108 |
| Arossa salt | Blue | 0.854 | Blue | 0.108 |
| Safi salt | Blue | 0.860 | Blue | 0.102 |
| Sasa salt | Blue | 0.858 | Blue | 0.110 |
| Masa salt | Blue | 0.857 | Blue | 0.110 |
| Iodine standard | High blue | 0.919 | High blue | 0.805 |
| Potassium iodide standard | High blue | 0.832 | High blue | 0.635 |

A: Ethanol : Ethyl acetate : water — 50 : 30 : 20 — B: Ethyl acetate : Acetic acid : water — 80 : 30 : 20

$$R_f \text{ : Rate of flow} = \frac{\text{Distance of sample}}{\text{Distance of solvent}} \text{ on (TLC)}$$

Table (3) show the content of heavy metals (ppm) in investigated iodized table salt. Data illustrated that Sasa salt contain high amount of Cobalt (Co) and Copper (Cu) 9.535 ppm, 3.105 ppm respectively than other samples and control pure salt. These data disagreement with those obtained by Ibrahim, *et al.* (2001), they indicated that copper (Cu) was 1.30, 1.10, 0.17, 1.20 and 4.0 ppm in NaCl salt of local production (non-private sector and

private sector), imported (from Jordan and Saudi Arabia) and El-Sayahaat salt, respectively. Where, Cu in investigated samples was low than local production, imported table salt and El-Sayahaat table salt. But Arossa salt contain little arnount (0.760 ppm). Also, data showed that lead (Pb) was high content in Sasa and Safi salt (6.055 and 6.025 ppm) than other Table salt and control pure salt. These data disagreement with that obtained by Ibrahim (2001) where lead (Pb) content of local production table salt from (1.10 – 1.30 ppm) and from (0.17 – 1.20 ppm) in imported table salt. While, El-Sayahaat table salt lead (Pb) concent was high (20.0 ppm) than the data obtained from investigated samples. All table salt contain Zinc (Zn) and Iron (Fe) low amount than control pure salt as control sample. Also, these results disagreement with those obtained by Ibrahim *et al.* (2001). They found that iron (Fe) content of table salt was (3.50 – 7.50 ppm), (1.70 – 4.90 ppm) and (13.0 ppm) in local production, imported and El-Sayahaat table salt, respectively. While, Zinc (Zn) content was (13.80 – 16.00 ppm), (14.00 – 17.00 ppm) and (5.00 ppm) in local production, imported and El-Sayahaat table salt, respectively. Minerals elements concentration in NaCl salts varied according to the kind of salt source and preparation method.

**Table (3): Content of heavy metals (ppm) in the investigated iodized (NaCl) salt samples.**

| Type of tested salt samples | Heavy metals (ppm) | | | | |
|---|---|---|---|---|---|
| | Co* | Cu | Pb | Zn | Fe |
| Pure salt | 6.250 | 2.290 | 4.940 | 19.930 | 47.575 |
| Arossa salt | 0.760 | 1.590 | 5.735 | 17.405 | 25.890 |
| Safi salt | 6.035 | 1.060 | 6.025 | 17.640 | 22.380 |
| Sasa salt | 9.535 | 3.105 | 6.055 | 19.825 | 36.770 |
| Masa salt | 6.620 | 2.675 | 5.560 | 18.515 | 22.105 |

*Co: Cobalt Cu: Copper
Pb: Lead Zn: Zinc Fe: Iron

Table (4) show the effect of adding iodine at low level (100 ppm to 500 ppm) to NaCl table salt on some pathogenic and non-pathogenic microorganisms. Data revealed that high effect for iodized salt (100 to 400 ppm) on *Staphylococcus aureus* as moderate sensitive (5 – 10 mm) zone than control treatment. Also, iodized salt (500 ppm) have high effect on *Listeria monocytogenes* as moderate sensitive (5 – 10 mm) zone than other adding iodine to table salt.

Results illustrated that there is no effect of iodized salt on both *Aspergillus flavus* and *Bacillus subtilis* as insensitive to iodized salt (< 1 mm) zone. Also, data showed that iodized salt had effect on *Saccharomyces cerevisiae* (200 ppm and 500 ppm) at 15% table salt and (200 ppm) at 20% table salt, as moderate sensitive (5–10 mm) zone to iodized salt under investigation.

**Table (4): Effect of adding low level of iodine (ppm) to salt NaCl on some pathogenic and non-pathogenic microorganisms using paper disc method.**

| Type of microorganisms | Concent-ration (%) | Adding iodine (ppm) to salt NaCl* | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 100 | 200 | 300 | 400 | 500 |
| *Staphylococcus aureus* | 15% | - | 8mm | 6mm | - | 6mm | - |
| | 20% | 7mm | 7mm | 7mm | 7mm | 8mm | - |
| *Listeria monocytogenes* | 15% | - | - | - | - | - | - |
| | 20% | - | - | - | - | - | 10mm |
| *Aspergillus flavus* | 15% | - | - | - | - | - | - |
| | 20% | - | - | - | - | - | - |
| *Bacillus subtilis* | 15% | - | - | - | - | - | - |
| | 20% | - | - | - | - | - | - |
| *Saccharomyces cerevisiae* | 15% | - | - | 7mm | - | - | 7mm |
| | 20% | - | - | 7mm | - | - | - |

**(15 – 20 mm): very high sensitive,**
**(10 – 15 mm): highly sensitive,**
**(5 – 10 mm): Moderate sensitive,**
**(1 – 5 mm): Slightly sensitive,**
**Nil (-) : Insensitive.**
***Mean value of two trials.**

Table (5) show the effect of adding high level of iodine to table salt (1000 ppm to 5000 ppm) on some pathogenic and non-pathogenic microorganisms using minimum inhibition concentrate zone (MIC). Data revealed that the adding of iodine (2000, 3000, 4000 and 5000 ppm) had high effect inhibition on *Staphylococcus aureus* than (1000 ppm) at 15% - 20%. While 20% table salt with iodine content as best inhibition than 15% with iodine content. The results in Table (5) illustrated that table salt at 15% with iodine (5000 ppm) gave high effect (on *Listeria monocytogenes*) than other treatments and control too. While table salt 20% with iodine (4000 and 5000 ppm) were better than other treatments on *Listeria monocytogenes*. Also, data in the same Table (5) revealed that table salt 15% with iodine content (4000 and 5000 ppm) minimum inhibition concentrate (MIC) zone were 6 mm and 7 mm (as moderate sensitive) for *Aspergillus flavus* respectively. While, table salt (20%) with iodine (1000, 2000, 3000, 4000 and 5000 ppm) minimum inhibition concentrate (MIC) zone were (6 mm, 6 mm, 6 mm, 8 mm and 8 mm) (as moderate sensitive) for *Aspergillus flavus*, respectively, too.

Data in Table (5) showed that table salt (20%) with iodine content better than (15%) with iodine content for *Bacillus subtilis* inhibition growth which consider as moderate sensitive to iodized salt.

Table salt (15%) with iodine content had high effect than (20%) at the same treatments for *Saccharomyces cerevisiae* at (3000 and 4000 ppm), but at (5000 ppm) table salt (20%) better than (15%) at the same concentration of iodine content. Finally, iodine content increased with table salt increased effect of minimum inhibition concentrate (MIC) zone for all pathogenic microorganisms than non-pathogenic microorganisms.

**Table (5): Effect of adding high level of iodine (ppm) to NaCl salt on some pathogenic and non-pathogenic microorganisms using disc method.**

| Type of microorganisms | Concent-ration (%) | Adding iodine (ppm) to salt NaCl* Minimum inhibition zone** | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 1000 | 2000 | 3000 | 4000 | 5000 |
| *Staphylococcus aureus* | 15% | - | - | 6mm | 6mm | 7mm | 8mm |
| | 20% | - | - | 6mm | 7mm | 9mm | 7mm |
| *Listeria monocytogenes* | 15% | - | - | - | - | - | 6mm |
| | 20% | - | - | - | - | 6mm | 7mm |
| *Aspergillus flavus* | 15% | - | - | - | - | 6mm | 8mm |
| | 20% | - | 6mm | 6mm | 6mm | 8mm | 8mm |
| *Bacillus subtilis* | 15% | - | 6mm | 7mm | 7mm | 7mm | 8mm |
| | 20% | 6mm | 7mm | 7mm | 8mm | 8mm | 9mm |
| *Saccharomyces cerevisiae* | 15% | - | 6mm | 7mm | 8mm | 8mm | 7mm |
| | 20% | - | - | - | 7mm | 7mm | 8mm |

*Mean value of two trials.
**(15 – 20 mm): very high sensitive,
(10 – 15 mm): highly sensitive,
(5 – 10 mm): Moderate sensitive,
(1 – 5 mm): Slightly sensitive,
Nil (-) : Insensitive.

Table (6) show the effect of different concentration of table salt (15% and 20%) fortified with iodine at (4000 and 5000 ppm) as the better treatment for inhibition the growth of total viable count in both pickles (Cucumber) and salted fish (Sardine) during storage periods.

These results were in agreement with Achinewhu and Oboh (2002) and Paludan, *et al.* (2002) whom indicated that total viable count (TVC) of microorganisms were slightly decreased in fermented and unfermented sardinella with decreasing pH from 6.5 to 4.3.

Data illustrated that total viable count (TVC) log (CFU/g) were increased during storage periods than control samples in pickles cucumber with 4000 ppm. except at 15% with (5000 ppm) were lower than control treatment through 10 to 15 days. On the other hand, during storage periods at 20% with 4000 ppm and 5000 ppm iodine, total viable count Log (CFU/g) (TVC) were lower in both than control after 10 days.

Data in Table (6) revealed that total viable count in Sardine fish treatments were little increased when storage periods prolonged with 15% table salt with 4000 ppm and 5000 ppm iodine. On the other hand, total viable count (TVC) CFU/g were decreased after 5 days with control treatment, at 20% NaCl concentration. While, adding iodine (4000 ppm and 5000 ppm) to 20% table salt, total viable count were little decreased than control treatment after 10 days except 4000 ppm at 20% through 15 days total viable count were higher than control treatment. The different variation in total viable count (TVC) CFU/g may be due to the adding iodine to table salt.

**Table (6): Effect of iodized salt (NaCl + iodine) on total viable count (TVC) (CFU/g) of microorganisms during storage at different concentration.**

| Sample | Treatments | Storage periods at room temperature (days)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | | 5 | | 10 | | 15 | |
| | | *X10⁴ | Log | X10⁴ | Log | X10⁴ | Log | X10⁴ | Log |
| Cucumber pickles | 15% Salt + control | 2 | 4.301 | 3 | 4.477 | 15 | 5.176 | 22 | 5.342 |
| | 15% Salt+4000ppm I | 2 | 4.301 | 6 | 4.778 | 18 | 5.255 | 61 | 5.785 |
| | 15% Salt+5000ppm I | 1 | 4.000 | 4 | 4.602 | 6 | 4.778 | 7 | 4.845 |
| | 20% Salt control | - | - | 1 | 4.000 | 90 | 5.954 | 119 | 6.076 |
| | 20% + 4000 ppm I | - | - | - | - | 33 | 5.519 | 40 | 5.602 |
| | 20% + 5000 ppm I | - | - | 1 | 4.000 | 88 | 5.944 | 98 | 5.991 |
| Sardine fish | 15% Salt + control | 3 | 4.477 | 10 | 5.000 | 9 | 4.954 | 17 | 5.230 |
| | 15% Salt+4000ppm I | 33 | 5.519 | 57 | 5.756 | 24 | 5.380 | 45 | 5.653 |
| | 15% Salt+5000ppm I | 6 | 4.778 | 15 | 5.176 | 1 | 4.000 | 3 | 4.477 |
| | 20% Salt control | 1 | 4.000 | - | - | 29 | 5.462 | 41 | 5.613 |
| | 20% + 4000 ppm I | 2 | 4.301 | 4 | 4.602 | 26 | 5.415 | 75 | 5.875 |
| | 20% + 5000 ppm I | 2 | 4.301 | 2 | 4.301 | 1 | 4.000 | 2 | 4.301 |

*** (CFU/g): Colony for unit.**
**** Mean value two trials.**
**(-) Not colony detected.**

Finally, the adding of iodine to table salt little affected the total viable count during fermention and storage periods in cucumber pickles and salted Sardine fish treatments where total viable count (TVC) log (CFU/g) of samples prepared with iodized salts were lower than total viable count with unfortified NaCl salts. These data were in agreement with that obtained by Azanza, *et al.* (1998).

From data in Tables (7 and 8) its clearly that all values were not significant between treatments with adding iodine to table salt and control samples at 5% and 1% level of significance. These data were in agree with that obtained by Azanza *et al.* (1998), they found that difference test using paired comparison were no significant difference detected in the over all acceptability of the test samples prepared with iodized and unfortified NaCl at 15% level of significance.

*Also, these results were disagreement with that obtained by* Achinewhu and Oboh (2002), whom reported that sensory evaluation of fish fermented in 10% salt solution significantly higher scores for flavor and overall acceptability than those fermented in 15% salt solution.

**Table (7) : Statistical analysis for sensory evaluation using iodized salt and unfortified NaCl salt with iodine for cucumber pickles after 15 days.**

| Treatments and NaCl concentration | Color 30 degree | | | Odor 30 degree | | | Taste 40 degree | | | Acceptability 100 degree | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X` | Sd | Se | X` | Sd | Se | X` | Sd | Se | X` | Sd | Se |
| 15% salt control | 27.00 | 2.00 | 1.15 | 27.00 | 1.73 | 1.00 | 33.00 | 2.65 | 1.53 | 87.00 | 6.00 | 3.46 |
| 15% salt + 4000 ppm (I) | 25.33 | 2.51 | 1.45 | 24.33 | 2.52 | 1.45 | 29.00 | 4.58 | 2.64 | 78.67 | 9.07 | 5.24 |
| 15% salt + 5000 ppm (I) | 22.67 | 4.16 | 2.40 | 22.67 | 4.16 | 2.40 | 24.00 | 4.36 | 2.52 | 69.33 | 12.50 | 7.22 |
| 20% salt control | 24.33 | 4.04 | 2.33 | 24.33 | 5.51 | 3.18 | 29.33 | 5.51 | 3.18 | 78.00 | 14.93 | 8.62 |
| 20% salt + 4000 ppm (I) | 24.33 | 4.62 | 2.67 | 23.67 | 4.93 | 2.84 | 29.33 | 5.50 | 3.17 | 77.33 | 15.04 | 8.68 |
| 20% salt + 5000 ppm (I) | 22.67 | 4.93 | 2.85 | 21.67 | 6.66 | 3.84 | 27.33 | 5.69 | 3.28 | 71.67 | 17.21 | 9.94 |

**All values were not significant.**
**X` = mean**
**Sd = Standard division**
**Se = Standard error of mean.**

**ANOVA for cucumber pickles**

| | | M.S | | | |
|---|---|---|---|---|---|
| S.O.V. | df | Color | Odor | Taste | Total |
| Between groups | 5 | 8.19 | 9.92 | 26.00 | 114.67 |
| Within | 15 | 14.94 | 20.94 | 23.33 | 170.06 |
| F. | | 0.548 | 0.47 | 1.11 | 0.47 |
| Duncans | | 0.237 | 0.22 | 0.06 | 0.161 |
| Sig. | | N.S | N.S | N.S | N.S |

**F. Table = 3.11 for 5% and 5.06 for 1%.**

**Table (8): Statistical analysis for sensory evaluation using iodized salt and unfortified NaCl salt with iodine for Sardine fish after 15 days.**

| Treatments and NaCl concentration | Color 30 degree | | | Odor 30 degree | | | Taste 40 degree | | | Acceptability 100 degree | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X` | Sd | Se | X` | Sd | Se | X` | Sd | Se | X` | Sd | Se |
| 15% salt control | 26.00 | 2.00 | 1.15 | 23.33 | 3.51 | 2.03 | 27.00 | 7.55 | 4.36 | 76.33 | 13.01 | 7.51 |
| 15% salt + 4000 ppm (I) | 27.33 | 0.58 | 0.33 | 25.67 | 1.15 | 0.67 | 30.66 | 2.31 | 1.33 | 83.67 | 2.52 | 1.45 |
| 15% salt + 5000 ppm (I) | 26.00 | 1.00 | 0.58 | 27.00 | 1.00 | 0.58 | 31.33 | 1.16 | 0.67 | 84.33 | 1.00 | 0.88 |
| 20% salt control | 25.67 | 2.31 | 1.33 | 26.00 | 2.65 | 1.53 | 32.33 | 0.58 | 0.33 | 84.00 | 5.29 | 3.06 |
| 20% salt + 4000 ppm (I) | 27.33 | 1.15 | 0.67 | 27.00 | 2.64 | 1.53 | 31.33 | 4.72 | 2.73 | 85.67 | 8.51 | 4.91 |
| 20% salt + 5000 ppm (I) | 27.00 | 1.00 | 0.58 | 27.33 | 0.58 | 0.33 | 34.33 | 1.53 | 0.88 | 88.67 | 1.15 | 0.67 |

**All values were not significant.**

**X` = mean** **Sd = Standard division**

**Se = Standard error of mean.**

**ANOVA for cured fish.**

| | | M.S | | | |
|---|---|---|---|---|---|
| S.O.V. | df | Color | Odor | Taste | Total |
| Between groups | 5 | 1.69 | 6.59 | 17.43 | 49.96 |
| Within | 15 | 2.17 | 4.83 | 14.78 | 46.61 |
| F. | | 0.78 | 1.36 | 1.18 | 1.07 |
| Duncans | | 0.23 | 0.067 | 0.056 | 0.069 |
| Sig. | | N.S | N.S | N.S | N.S |

**F. Table = 3.11 for 5% and 5.06 for 1%.**

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# تأثير الملح اليودى على بعض الميكروبات الممرضة وغير الممرضة وتطبيقاتـــها فى جودة الأسماك والمخللات.

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يهدف البحث إلى دراسة تأثير الملح اليودى والملح العادى غير المدعم باليود علـــى بعـــض الميكروبـــات الممرضـــة والغـــير ممرضـــة وهـــى: (*Staphylococcues aureus, Listeria monocytogenes, Aspergillus flavus, Bacillus subtilis and Saccharomyces cerevisiae*) على بيئات متخصصة. وتم تحديد التركيز المثبط الأدنى لعينات ملح الطعام بتكنيـــك الأقـــراص الورقية.

- وقد أظهرت الدراسة أن للملح اليودى تأثير أعلى على الميكروبات الممرضة عن الميكروبات غير الممرضة ويزداد التأثير بزيادة التركيز (تركيزات مستوى منخفض لليود ومستوى مرتفع لليود).
- كما تم التفرقة بين مصادر الملح اليودى عن طريق تقدير محتوى الأملاح المعدنيـــة الثقيلـــة (الكوبالت – النحاس – الرصاص – الزنك – الحديد) حيث أظهرت النتائج اخـــتلاف كبـــير لمحتويات الأملاح من هذه المعادن.
- وقد تم تحديد مكونات تلك الأملاح على كروماتوجرافيا الطبقة الرقيقة (TLC) وتحديد قيمة $R_f$ تحت لمبة الأشعة فوق البنفسجية (UV) بعد رشها بمحلول النشا مع استخدام نظامين لمعـــدل سريان المذيب.
- وتم تطبيق إضافة اليود إلى ملح الطعام بتركيزات ٤٠٠٠، ٥٠٠٠ جزء فى المليون كـــأفضل للمعاملات فى عمليات التخليل للخيار وكذا فى التمليح الرطب لسمك السردين. وقد أظـــهرت النتائج أن العد الحيوى الميكروبى يزداد زيادة بسيطة أثناء التخزين نظراً لتأثير الملح اليـــودى ونواتج التخمر.
- كما تم تقدير الخواص الحسية (اللون – الطعم – الرائحـــة – ودرجـــة القابليـــة) للمعـــاملات المختلفة حيث تم تحليل النتائج احصائيا. وأوضحت النتائج الإحصائية أنه لا توجـــد فـــروق معنوية للخواص الحسية بين المعاملات المختلفة وهذا يعنى حماية المستهلك من الميكروبـــات الممرضة مع الحفاظ على جودة المنتج المرغوبة.