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Evaluation of mustard seed properties and the antibacterial potential in meat preperation.

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Abstract

Seeds of Sinapis alba is commonly known as white or yellow mustard and it is a most common species used in food. Moreover; it is used in produce medicine, pickles, source of edible oil since ancient times, seasoning of meats and chicken. The present study was undertaken to determine chemical components of mustard powder, and used in grilled beef as a seasoning to improve sensory and physical properties, as well as inhibiting *Escherichia coli, Staphylococcus aureus* and increase shelf life of meat. Mustard powder contained higher amounts of both protein 36.69%, and oil 40.64%.Oil of mustard seed contained high amount of erucic acid 51.3%, and the major dominant unsaturated fatty acids were, oleic acid followed by linoleic and linolenic acids. Sensory evaluation of the grilled meat slices showed high significant effect, especially in odor, in the acceptability of meat treated with 2.0% mustard powder. The addition of 1.5 or 2.0% of mustard powder to fresh meat reduced the natural flora to undetectable levels at 4 or 30 °C till 2days from storage. At 1.5, 2.0% of mustard powder was able to reduce *E.coli* number to uncountable levels at zero time and till 3 days at 4°C .The same effect was scored by mustard powder 2.0% against *Staph. aureus*, and it improved the physical properties of meat at 4°C during 6 days of storage time. The study recommended that mustard powder at 2% is considered, antibacterial, anti- microflora, natural preservative spices in food. Also it improves taste, odor and physical properties of meat and increase shelf life of meat. Further study in this area may be helpful for finding of new principle compound.

Key words: Antimicrobial, E.coli , Staph. aureus, Mustard powder, fatty acids.

Introduction

Mustard plant belongs to the Cruciferae (Brassicaceae) family. Sinapis alba L. (white or yellow) is the most common species used in food. The spice trade of Sinapis alba is commonly known as "white" or "yellow" mustard, it is added to food to make it "hot", and induce a feeling of warmth and sweetness ***(Cuhra, et al., 2011).*** Mustard powder is the second type of spice commonly consumed instead of pepper, and used in medicine, pickles, a source of edible oil since ancient times, seasoning of meat and chicken, as well as, various traditional remedies to stimulate appetite, as a laxative, and antiseptic agent for the treatment of various gastrointestinal, respiratory and skin diseases. The seed of mustard plant can be a good source of active components such as, isothiocyanates, phenolics, dithiolthiones and dietary fiber ***(Hendrix, et al., 2012).*** Also, it contains special compounds namely glucosinolates, which degraded into isothiocyanates by enzymatic action of plant specific myrosinase under normal conditions or intestinal flora in the body. Isothiocyanates is natural component may be used as a source of inhibiting of food born disease , as well as cancer cells ***(Rhee, et al.,2003 Talati,et al.,2004, and Tyagi, et al., 2007).*** Moreover, the yellow mustard seed is a source of natural antioxidants such as; tocopherole, compounds of hydroxybenzoic family, Trihydroxy phenolic compounds like

flavones, flavonols (kaemferol, isorahmnetin) and ascorbic acid which protect oil from rancidity in emulsion ***(Honda et al., 2005 & Kırca et al., 2007).***

The yellow mustard seed is a Good source of edible oil 38-44%, which contains the highest percentage of erucic acid (23.90-37.89%).Moreover, considerable amounts of major unsaturated fatty acids were found; oleic, linoleic, and gadoleic. The percentage of protein in mustard seed ranges from 31 to 36%, which contain sulfur amino acids; Methionine cystine, leucine, valine and lysine. This part of mustard is a representative flavor detected as pungency and is also related with bitterness. Moreover, the protein is rich with aromatic amino acids (Phenylalanine and tyrosine). So, Mustard seed protein had a good functional property, such as solubility of protein, stability of emulsion and foam (***Zhang et al., 2006 & Abul-Fadl et al., 2011).***

Meat and meat products are rich in protein, fat, and minerals, and may practice as vehicles of borne disease, if not good hygiene in manufacture or handling from animal ***(Mead et al., 1999).*** There are two ways to spread diseases from meat to humans. The first one is direct contact, and includes streptococcal skin infections, anthrax, viral and fungal diseases, brucellosis, Q fever and other organisms, that confined to workers in the meat and livestock slaughter house or factories***(Aitken,1996).***The second way of contamination is by ingestion, that slaughter house or factories may cause illness in large number of consumers. In an epidemiological survey performed in England focusing on *Salmonella, Clostridium perfringens, Staphylococcus aureus* and *Bacillus spp*. the study showed that poultry and beef were scored 49% and 27% cases of food borne disease to human***(Sockett, 1995).***

More than 200 known causative agents could cause foodborne diseases; these include viruses, bacteria, parasites, prions, metals and toxins. The symptoms of foodborne illnesses vary and ranged from mild gastroenteritis to life-threatening neurologic, hepatic, and renal syndromes ***(Mead et al., 1999).***The annual incidence of microbiological foodborne illnesses is determined to be around 30% of the population in developed counties ***(De Guisti et al., 2007).***

In recent years, there is increased demand for natural products that can be used as alternative food preservative (Tajkarimi *et al.,* 2010).This is a chance to search for antimicrobial agents derived from a variety of natural sources. ***Kanemaru and Miyamoto, (1990)*** used 0.1% mustard powder to inhibit E. coli within 24 hours; it was more effective against pathogens than purified isothiocyanates. The mustard was used to eliminate 6 log10 of E. coli O157:H7 to be 0.3 log10 in 24 h from trypticase soy broth at room temperature ***(Mayerhauser, 2001).*** The order of bacterial resistance to mustard were assessed by time that reduced bacterial counts to undetectable levels at 5**°C**, were Salmonella typhimurium (1 day) < E.coli O157:H7 (3 days) < Listeria monocytogenes (9 days) ***(Rhee et al.,2003).***

The objective of the present study is to deactivate *E.coli* and *Staphylococcus aureus* in grilled meat with mustard powder as a seasoning, and then evaluate their sensory acceptable and physical properties during storage time.

Materials and Methods

Materials

Mustard seeds powder.

The Sinapis alba seed (yellow mustard) spicey were collected from the local market in Giza, Egypt.

Meat.

Fresh meat was purchased from local butcher shop the day before each experiment. The meat was stored at 4 °C overnight, then was kept at -18°C for 3 hrs. until the outer surface was frozen. This procedure was carried out in the kitchen research unit ,Food Technology Research Institute.

Bacterial Strains.

Two reference strains – *Staphylococcus aureus* ATCC25923 and *Escherichia coli* ATCC 25922 were obtained from microbial culture collection, Department of Microbiology, Faculty of Agriculture, Cairo University, Cairo, Egypt. Strains were activated on Nutrient broth (NB) at 37 °C for 24 h.

Methods

Chemical composition of mustard seeds powder.

The seeds were cleaned and grained to get mustard powder rich with active components. The Analyses of moisture, ash, total carbohydrates, crude protein, crude fiber and fat were determined for the dried mustard seeds powder as described by the ***(AOAC ,2005).***

Determination of fatty-acid content.

Fatty acid content of samples was determined by Gas Chromatography.Carlo Erba Fractovap after KOH methanol hydrolysis and BF derivation. Supelcowax 10 column capillary Ž 3 length 15 m, diameter 0.25 mm, film thickness 25 m. was used. The temperature of the injector and detector was 225^{o}C (***Xu and Beardall, 1997).***

Meat preparation.

Meat was prepared using aseptic procedures, sterile utensils and sanitized equipment. The meat was cut into 5X5X1 cm pieces, each one equal 100 gm, and then held it at 4^{o}C for 1 h. The meat which was previously described **.**For control sample, 2 gm salt was added to each piece .Treatment samples 2 gm salt plus different concentrations of mustard powder (0.5, 1.0, 1.5, 2.0, and 2.5%) to get 5 group samples. All samples were cooked on grilled at 200°C until the internal temperature reached to 71^{o}C. Grilled meats were kept at 60°C until they were served to the panelists.

Sensory evaluation.

Sixty staff at the Food technology research institute who had received no formal training in sensory evaluation participated. Panelists were 30-60 years old and 75% were female. Each panelist received three 10 gm samples of grilled beef in a container coded with a randomly chosen three digit number, plus water. The panelists tasted samples and recorded the overall acceptability of each treatment product according to colour, odor, taste, and consistency. The experiments were repeated at least five times ***(AMSA, 1995).***

Effect of mustard powder on bacterial counts in meat slices.

After preparing meat pieces inoculated with bacterial strains and treated with mustard powder, the experiment was divided into two sections; the first section meat slices were thawed at 4°C overnight, then adding 0.5, 1.0, 1.5, 2.0 and 2.5%mustard powder and salt before grilling. Total count (natural flora) of each sample was evaluated before and after treatment (seasoning) and subdivided into 2 parts, one was stored for 2 days at 4°C and other was stored at 30°C.

The second section, were grilled meat slices, then adding 0.5, 1.0, 1.5, 2.0 and 2.5 % mustard powder and salt plus inoculation with 0.5 ml (1×10^{5}cfu/ml) reference strains. All samples were kept in aluminum foil trays under sterilized conditions for 24 hours at 4°C or 30°C. Total bacterial counts were determined periodically after 0,1,2,3, and 6 days according to the procedure mentioned by ***APHA(2001).***only salt were added in control samples.

Physical properties

pH Value . pH value of meat product samples was examined according to the method as reported by **Ockerman (1985).**

Quality properties

Determination of Total Volatile Bases Nitrogen (TVB-N). Total volatile nitrogen was determined according to the method described by ***(Winton and Winton, 1958).***

Calculation : The milligrams of TVB-N per 100 gm sample were obtained by number of milliliters of bound acid x 7.0.

Determination of Thiobarbituric Acid Value (TBA) Malon aldehyde (The compound used as an index of lipid peroxidation) was determined following the procedure of ***Egan et al., (1987).***TBA value was expressed as mg malonaldehyde / kg sample by using the following equation: TBA value (Mg malonaldehyde / kg sample) = absorbance x 7.8

Statistical analysis.

The data obtained from treatments were analyzed by one-way ANOVA using 'Proc Mixed' (SAS 8.2, Cary, NC, USA). In all cases, the level of statistical significance was at P <0.05. SAS program was used to statistical analyzed ***(SAS 2001),*** LSD means comparisons were conducted with the Duncan option in SAS.

Results and Discussion

Table: 1 Shows the Chemical Composition of yellow mustard Seed powders. Mustard powder contained high amounts of both protein and oil. These high protein and oil contents in mustard seed varieties are similar to the results published by other authors ***(Cserhalmi et al.,2001; Sen and Bhattacharyya 2003 & Sharma et al., 2011).*** From the same table, it could be also observed that, Mustard powder contains an adequate percentage of ash, and total carbohydrates. Further, Sinapis alba seed are contains phenol, falvonoids, alkaloids, sterols, terpenes, isothiocyanates, dithiolthiones and dietary fiber and ascorbic acid which protect oil from rancidity in emulsion ***(Honda et al., 2005 & Kırca et al., 2007).*** Mustard powder protein had a good functional property, such as solubility of protein, stability of emulsion and foam.

The fatty acids composition of yellow mustard seeds oil was determined by gas chromatographic analysis (Table:2). It is clear from the results, that erucic acid (C22:1) was the most predominant fatty acids in mustard seed oil, ~(51.03%). The limiting factor of mustard seed oil for use in human food application or animal feed formulation was highest content of erucic acid. Mustard oil rich in erucic acid is considered undesirable and indigestible for human or animal organisms. It could be remarked that mustard seed oil contained a small amount from total saturated fatty acids~(6.93%) as compared to the other edible oils. These results are in agreement with previous reviewer ***Zheljazkov et al., (2012)*** who reported that mustard oil has low saturated fat compared to other cooking oils ***(Kanrar, et al 2006).***In contrary, the total unsaturated fatty acids in mustard seeds oil were considerably a highly in amount (85%). The major types of unsaturated fatty acids were namely; Oleic, linoleic, and linolenic acids. In addition, linoleic acid and linlolinic are the most prevalent unsaturated fatty acids, and it is the most important of the essential fatty acids. These results are in accordance with the data previously obtained by ***Sharma,et al., (2011) & Iidiko et al., (2006)*** represented that the mustard oil has a special fatty acid composition. Where poly unsaturated fatty acids were scored in little amounts but it contained arachidonic acid which is one of the important essential fatty acid.

Table (1)

Chemical composition profile of yellow mustard powder content.

*Components%	Moisture	Protein	Ash	Oil	*Carbohydrate
	1.78	36.96	4.42	40.64	16.20

*Carbohydrate is calculated by difference; **All components are determined on dry weight.

Table (2)

Fatty acids profile of yellow mustard powder content.

Fatty acids % (g/100g)			
Saturated fatty acids %		Mono-unsaturated fatty acids	
Palmitic C16: 0	2.27	Erucic C22:1	51.03
Stearic C18:0	1.05		
Lignoceric C24:0	0.94	Palmitoleic C16:1	0.04
Arachic C20:0	1.062	Oleic C18:1	8.08
Behenic C22:0	1.58	Nervonic C24:1	2.27
Total	6.90	Total	61.42
Poly-unsaturated fatty acids			
Linoleic C18:2	11.76	Linolenic C18:3	10.66

**All components are determined on dry weight.

In table 3, the color, odor, taste, Consistency and overall acceptability of grilled meat slice samples are shown as effected by the different concentrations of yellow mustard powder (0.00%, 0.5%, 1.0%,1.5%. 2.00%,and 2.50%). Along with the increase in mustard content from 0% to 2.0%, all characteristics of sensory evaluation score improved considerably from 3.08to 4.94. The sensory evaluation has highly significant effects on odor of grilled meat slices were scored at 2.0%mustard powder. This result proves the advantage of yellow mustard as the strong flavoring component of meat slices. With the increase of mustard powder by 2.00%, the mean of taste score increased to 4.66.The application of heating treatment in grilled meat slices led into myrosinase enzyme deactivation, isothiocyanate reduction and thus reduction of pungent taste in mustard powder. The results were not in line with the findings of ***(Milani et al., 2014; Barath et al., 2000 & Balint et al.,2006),*** they concluded that , mayonnaise, containing mustard paste gave a higher smell in comparison with the samples, containing mustard powder and control sample. They explained that in higher concentrations of the yellow mustard powder, this proliferation causes a pungent taste in mayonnaise. It was a result of an increase in the content of isothiocyanate, following the activity of myrosinase enzyme in mustard powder. So use of heating treatment and the production of mustard powder improve the smell. Hence, meat slices with heat (grilled) after seasoning by mustard powder may be a main reason to improve smell of meat at high concentrations from powder 2.0%. From the sensory evaluation the candidates chose the best acceptable concentration to the arbitrators was 1.5 and then 2%.

Table (3)

Sensory evaluation of grilled meat slices treated with mustard powder.

%Mustard powder	Colour	Characteristics		Consistency	Total
		Odor	Taste		
control	3.08±.03	3.08±.03	3.08±.03	3.54±0.20	12.78
0.5%	3.64±0.18 a**,c,d***	3.78±0.25 a **,c,d***	3.58±0.25	3.82±0.16c**,d***	14.82 a **,c,d***
1.0%	3.80±0.27a,d**	3.50±0.24c,d***	3.82±0.28,d**	3.64±0.22c*,d**	14.76 a,d**
1.5%	4.42±016. a,b,e ***	4.66±0.18 a,b,c,e***	4.00±0.28,a ***,d**	4.38±0.18 a,e***,b*,c,**	17.46a,e***,b*,c,**
2.0%	4.76±0.19 a,b,c,e***	4.94±0.04 a,b,c,e***	4.66±0.1 a,b,e***,c,**	4.30±0.18 a,b,c,e***	18.66a,b,c,e***
2.5%	3.28±0.19d***	3.34±0.17d***	3.40±0.18	3.89±0.17d***	13.91 d***

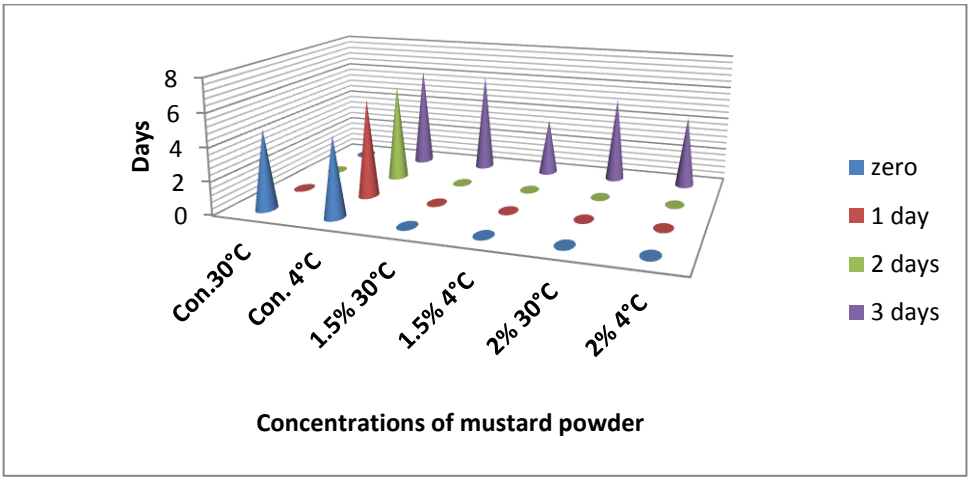
Values are expressed as means ±SE. (Standard Error of the Mean) of the three replicates). a: significantly different from the control group; b: significantly different from the concentration .5% c: significantly different from the concentration 1%. d: significantly different from the concentration 1.5% e: significantly different from the concentration 2%.Asterisk indicate the level of significance ($^{*}p < 0.05$; $^{**}p\ 0.01 < {}^{***}p < 0.001$.).

Antibacterial effects of Mustard powder were done by well diffusion method. Whereas, it was considered that the antibacterial activity against *E.coli & Staph. aureus* were 28 & 22 mm zone inhibition respectively. This result are the same finding by ***(Tomar and Shrivastava , 2014).***the maximum zone of inhibition of *Staph. aureus* & *E.coli* which affected from extraction of black mustard seed by ethanolic were determined (25mm & 20.5mm respectively).

Another way used to measure the antibacterial effect of mustard powder, when used it as seasoning against the natural flora present in meat slices stored at 4°C or 30°C. From the obtained results in Fig (1), fresh meat which was seasoning with mustard powder 1.5 & 2.0% was able to reduce the natural flora to undetectable levels until two days of storage at different temperatures , while the control sample spoilage after 24 hrs. at 30°C.It is clear from this study that adding mustard powder to fresh meat slices, preserved it from contamination and reduced the natural microflora for 2 days before being cooked at any temperature. This finding is in parallel with the work of ***Milani et al., (2014)*** who reported that the increase in amount of mustard powder in mayonnaise leads to decrease in microbial population compared with the control sample. It showed a decrease in microbial population with 68% in Mayonnaise that contained 1.5% mustard powder. Also, ***Nadarajah et al .,(2005)*** concluded that, the natural anaerobic microflora in meat treated with10% mustard powder was significantly lower on days 3,12 and 21 storage as compared to control sample.

Fig (1)

Effect of seasoning with mustard powder on the natural flora present in meat slices.



Escherichia *coli* is an important contamination indicator and its pathogenic strains is a serious public health concern in the world, it is common in the poultry meat. The most important Food-borne diseases is caused by agents such as (E.coli, Salmonella, and Staph aureus) that enter the body through the intake of contaminated food materials are one of the primary public health concerns in the world ***(Tan et al., 2013).*** Moreover, the antibiotic resistance of bacteria is a potential threat to food safety and public health. The antimicrobial effects of mustard powder *E.coli or Staph. aureus* ,when inoculated at 3.6 Log cfu/g in meat slices before grilling are shown in Fig.2. Mustard powder 1.5, 2.0% were able to reduce *E.coli* number to uncountable levels at zero time and till 3 days at 4°C.The same effect was scored by mustard powder 2.0% against *Staph. aureus* Fig 3. While, ***Nadarajah et al.,(2005)*** used low initial 3 log cfu/gm of *E.coli* O157:H7 was reduced to undetectable level after 18,12 and 3 days with 5, 10,20 % mustard powder the meat .They also concluded that it is possible to use mustard powder at levels > of 5-10% to eliminate *E.coli* O157:H7 in fresh ground beef. ***Nilson et al., (2012)*** inoculated 7.5 log cfu/g of *E.coli* with 4,4%(W/W) deodorized mustard powder was surface applied and monitored 80 days. At 21days bacteria was reduced by 3 log cfu/g as compared to control sample to only a 1 log cfu/g were reduction from cells. ***Milani et al.,(2014),*** they summarized that the high concentration of yellow mustard led to less microbial population and longer shelf life of mayoniase.

In the present study *Staph. aureus* were less significantly affected by mustard powder1.5% than *E.coli* , it showed reduction in their number by one log cfu/gm within 2days at 4°C. It is similar to the study of ***Abdul Rahman et al., (2010)*** they found that the good antibacterial effect from mustard is against *Staph. aureus*. This results explained that, Gram-positive bacteria of *Staph. aureus* was found to be less susceptible to mustard powder in meat than *E.coli*. These results are not accordance with findings of other investigations ***(Ouattara et al., 1997).*** They reported that, the Gram-positive bacteria of *Staph. aureus* was found to be more susceptible to spice samples, and explained this due to their structural features, are more susceptible to phenolic compounds than Gram negative bacteria . This may be due to the presence of polar and non-polar antimicrobial principles in the powder. The mustard oils unsaturated fatty acid composition.

Fig (2):
Effect of seasoning with mustard powder on the survival of inoculated E.coli in grilled meat slices.

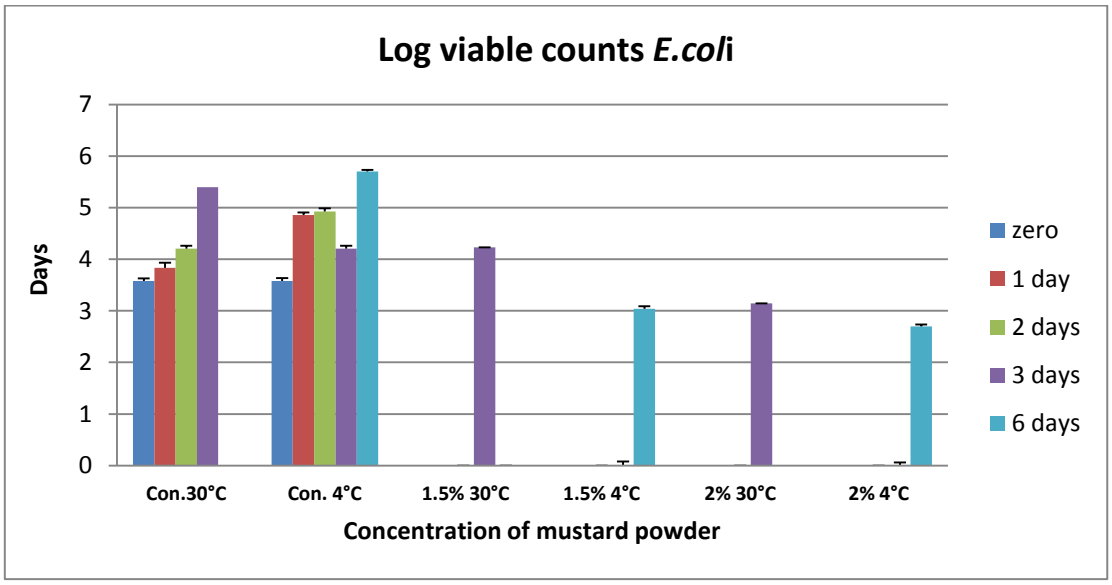
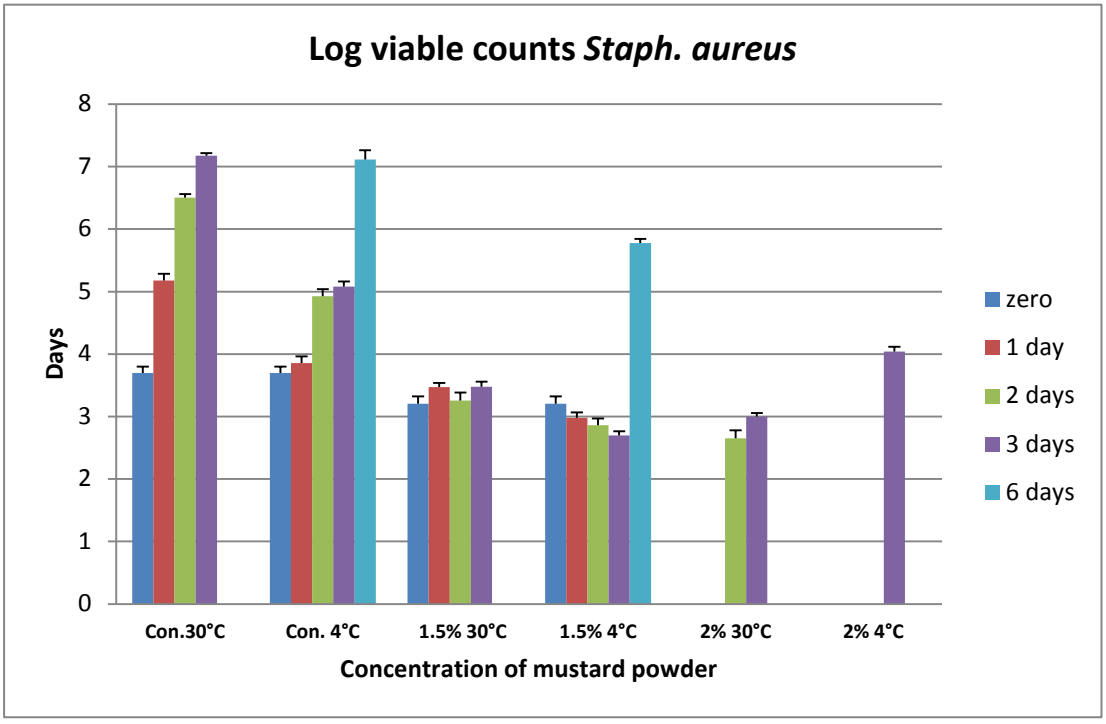


Fig (3):
Effect of seasoning by mustard powder on the survival of inoculated Sta ph. aureus in grilled meat slices.



Results showed in table (4,5) revealed that pH, TVN and TBA values of examined grilled meat slices inoculated with E.coli , Staph. aureus, plus concentration of mustard powder, at different time and temperature. pH in grilled meat slices inoculated with E.coli ranged from 5.9 to 6.2 at 4°C and 30°C were with1.5, 2.0% of mustard powder. These results were not significantly different from the control sample. These results nearly agree with the results were scored by ***Shedeed, (1999)*** with value 6.10 and ***Afifi- Jehan,(2000)*** with value of 6.15.

In this study, samples were treated by *Staph. aureus* plus mustard powder showed the pH ranged from 6.0-6.3except, samples kept at 30°C were higher in pH (6.2-6.7) during the storage time. The increase of pH may be due to the partial proteolysis However, the ideal pH for meat is between 5.8 and 6.3 ***(Pearson and Gillette, 1996).*** The meat with high pH has dark color and a great risk on human health.

The lowest pH was revealed in grilled slices at 4°C treated with 1.5, 2% mustard powder till 6 days of storage and reached to 5.3, except samples kept at 30°C were spoiled after 6 days (table 6). The decrease in pH value may be attributed to the breakdown of glycogen with the formation of lactic acid and, Poultry meat with a pH below 5.8 had a pale color. The mustard powder 1.5, 2.0% could be used to keep the pH of grilled meat in ideal state till 6 days storage at 4°C. Also it could be used if the meat was exposed to infection with pathogens.

The present results showed that, the TBA was the lowest significant value ranging from 0.22 to 0.62 after 3 day of incubation at 30°C,4°C , this result was the same obtained from control samples. While the TBA value 2.5-1.9 scored higher level than ideal value in grilled meat without any treatment. Moreover, TBA (mg%) in the grilled meat slices were decreased to the lowest significant value (0.62) at 2% mustard powder, at 30 °C and 4°C till 6 days as compared with the control sample(1.6). Whereas the Egyptian Organization for Standardization ***E.O.S, (2005)*** recommended that meat was accepted when TBA value was lower than 0.9 mg%. On the other hand, Lowe results were scored by ***Afifi Gehan, (2000) and Youssef. Fatma, (2013)*** that ranged from 0.119mg to % 0.09mg %. The oxidative rancidity in meat was

evaluated by measuring malonaldehyde in fat meat with an improved thiobarbituric acid (TBA) assay with antioxidant protection ***Abd El-Kader, (1996).***

Value of TVN (mg) in grilled meat slices treated with 2% mustard powder decreased at different temperature. Furthermore, sample with 2% mustard powder, kept at 4°C and inoculated with *E.coli* has low TVN value 5.2, and 7.3 after storage at 3,6 days . Higher results were obtained by ***Youssef.Fatma, (2013), and Afifi- Jehan ,(2000)*** with TVN value of 9.11 and13.87 (mg%).Ammonia is one of the most spoilage end products in contaminated meat, it is an indicator for amino acid degradation by bacteria . So it is directly pointer for spoilage odors and flavors ***Gill,(1983).***The Egyptian Organization for Standardization ***E.O.S, (2005)*** who recommended that meat was accepted when TVN value was lower than 20 mg%. The physical properties results at these study treated grilled meat with mustard powder in table 4, and 5 were in the range of E.O.S as compared to untreated sample with mustard powder in Table 6. The grilled meat without seasoning by mustard powder showed highly significant increase in physical properties after 3days of storage, and spoilage after 6 days.

Table (4)

Physical properties of meat slices treated with mustard powder and E.coli.

		pH				TBA%				TVN%			
		0	3	6	LSD	0	3	6	LSD	0	3	6	LSD
30ºC	Control	6.06^{Aa}	6.20^{Aa}	6.25^{Aa}	0.22	0.32^{Ab}	0.43^{Ab}	1.64^{Aa}	0.23	8.40^{Ac}	10.50^{Ab}	14.00Aa	0.06
	1.5%	6.01^{Ab}	6.06^{ABab}	6.20^{Aba}	0.17	0.22^{Bb}	0.29^{BCb}	0.94^{Ca}	0.10	6.65^{Bc}	9.10^{Bb}	11.55Ba	0.98
	2%	5.99^{Ab}	6.02^{ABab}	6.09^{BCa}	0.09	0.18^{Cb}	0.23^{Cb}	0.87^{CDa}	0.05	4.90^{Cc}	5.95^{Cb}	8.05Da	1.27
4ºC	Control	6.06^{Ab}	6.09^{ABab}	6.19^{Aba}	0.12	0.33^{Ab}	0.38^{ABb}	1.12^{Ba}	0.06	8.40^{Ac}	9.10^{Bb}	11.55Ba	0.90
	1.5%	6.01^{Aa}	6.02^{ABa}	6.07^{BCa}	0.14	0.217^{Bb}	0.27^{Cb}	0.77^{DEa}	0.08	6.65^{Bc}	8.40^{Bb}	10.50Ca	0.90
	2%	5.99^{Ab}	5.99^{Bb}	6.00^{Ca}	0.01	0.18^{Cb}	0.219^{Cb}	0.64^{Ea}	0.07	4.90^{Cb}	5.25^{Cb}	7.35Ea	0.57
LSD		0.10	0.44	0.124		0.01	0.09	0.15		0.36	1.13	0.51	

Different small letter = significant difference between treatment and time of storage; Different capital letter = significant difference between control and other treatments.*Sp= spoiled sample.

Table (5)

Physical properties of meat slices treated with mustard powder and Staph. Aureus

		pH				TBA%				TVN%			
		0	3	6	LSD	0	3	6	LSD	0	3	6	LSD
30ºC	Control	6.06Aa	6.21ABa	6.25Ba	0.22	0.33Ac	0.76ADEb	1.64Aa	0.23	8.4Ac	10.5Ab	14.0Ab	0.23
	1.5%	6.02Ac	6.27Ab	6.85Aa	013	0.28Bc	0.44Cb	1.067BCa	0.15	7.3Bc	9.8ABb	11.9Ba	0.23
	2%	6.01Ab	6.19ABb	6.73Aa	0.23	0.22Cb	0.28Db	0.93CDa	0.06	5.9Cc	7.0Db	9.8Da	0.40
4ºC	Control	6.06Ab	6.09BCab	6.20Ab	0.12	0.33Ab	0.38CDb	1.12Ba	0.06	8.4Ac	9.1BCb	11.5Ba	0.90
	1.5%	6.02Aa	6.03Ca	6.09Ba	0.08	0.28Bc	0.57Bb	0.84Da	0.11	7.3Bc	8.7Cb	10.8Ca	1.30
	2%	6.01Ac	6.03Cb	6.05Ba	0.02	0.22Cb	0.25Eb	0.62Ea	0.09	5.9Cc	6.6Db	8.4Ea	0.57
LSD		0.08	0.14	0.28		0.04	0.12	0.15		0.41	0.95	0.36	

Different small letter = significant difference between treatment and time of storage; Different capital letter = significant difference between control and other treatments.*Sp= spoiled sample

Table(6)

Physical properties of meat slices treated with mustard powder and stored at different temperature.

		0	3	6	LSD	0	3	6	LSD	0	3	6	LSD
30ºC	Control	5.46Ab	5.80Aa	Sp	0.20	0.07Ab	2.59Aa	sp	0.14	11.20Ab	41.30Aa	sp	1.58
	1.5%	5.26Bb	5.31Ca	Sp	0.03	0.06Ab	1.95Ca	sp	0.011	9.80Bb	32.20Ca	sp	1.58
	2%	5.10Bb	5.13Ea	Sp	0.01	0.04Bb	1.72Da	sp	0.06	8.40Cb	24.85Da	sp	1.68
4ºC	Control	5.46Ab	5.71Ba	Sp	0.20	0.07Ab	2.27Ba	sp	0.481	11.20Ab	34.30Ba	sp	1.58
	1.5%	5.26Ba	5.24Da	Sp	0.03	0.06Ab	1.268Ea	sp	0.064	9.80Bb	25.90Da	sp	1.58
	2%	5.10Ba	5.12Fa	Sp	0.01	0.04Ab	1.10Ea	sp	0.225	8.40Cb	20.30Ea	sp	1.12
LSD		0.18	0.01	-		0.01	0.22	-		1.017	1.368	-	

Different small letter = significant difference between treatment and time of storage; Different capital letter = significant difference between control and other treatments.*Sp= spoiled sample

Conclusion

The results of the present study highlighted the effect of mustard powder,it possessed good antimicrobial activity against natural microflora present in fresh meat, and reduced bacteria to undetectable levels until two days of storage at different temperatures, while the control sample was spoiled after 24 hrs. at 30°C. The mustard powder was able to reduce *E.coli* and *Staph. aureus*. number to uncountable levels at zero time and till 3 days of storage at 4°C. Also, mustard powder was easy to use at home or in factories to increase shelf life products. Further study in this area may be helpful for finding of new principle compound.

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تقييم خواص بذور المستردة وتأثيرها المضاد على البكتريا فى اللحوم المجهزة

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الملخص العربى

تعرف بذور ال Sinapis alba باسم الخردل الأبيض أو الأصفر ، وهي أكثر الأنواع استخداما في الاغذية حيث انها تستخدم في انتاج المخللات ، وتتبيل اللحوم والدجاج ، كما انها مصدر لزيت الطعام منذ العصور القديمة ، والعديد من المجالات الطبية. لذا أجريت الدراسة الحالية لتحديد المكونات الكيميائية لدقيق الخردل ، وثم استخدمه في اللحم البقرى المشوي كتوابل لتحسين الخواص الحسية ، والخصائص الفيزيائية ، وكذلك تثبيط بكتريا الإشريشيا كولاي ، والمكورات العنقودية الذهبية وزيادة مدة صلاحية اللحوم. يحتوي مسحوق الخردل على كميات كبيرة من كل من البروتين 36.69٪ ، والزيت 40.64٪. وكذالك ، احتوى زيت الخردل على كمية عالية من حمض الإروسيك بنسبة تصل الى 51.3٪ ، وكانت الأحماض الدهنية الرئيسية غير المشبعة هي حمض الأوليك يليه حمض اللينوليك واللينولينيك. أظهر التقييم الحسي لشرائح اللحم المشوي وجود تأثير معنوي بدرجة عالية للخواص الحسية ،و خاصة في الرائحة للحم المعالج بمسحوق الخردل بنسبة 2٪. واظهرت النتائج أن إضافة 1.5 أو 2٪ من دقيق الخردل إلى اللحم الطازج إلى تقلل الفلورا الطبيعية إلى مستويات غير قابلة للاكتشاف عند 4 أو 30 درجة مئوية حتى يومين من التخزين.

ويتضح من النتائج أن 1.5 أو 2 ٪ من مسحوق الخردل كان قادرا على تقليل عدد خلايا الإشريشيا كولاي إلى مستويات لا تعد ولا تحصى في وقت الصفر وحتى 3 أيام عند 4 درجة مئوية ، وسجل مسحوق الخردل 2 ٪ نفس التأثيرالمثبط للمكورات العنقودية الذهبية ، كما تم تحسين الخصائص الفيزيائية للحوم عند 4 درجات مئوية خلال 6 أيام من وقت التخزين.و توصي الدراسة الى: استخدام مسحوق الخردل بتركيز 2 ٪ حيث يعتبر مضاد للبكتيريا ، وتوابل حفظ طبيعية في الغذاء ، ويحسن الطعم الرائحة ويحافظ على الخواص الفيزيائية للحوم طبقا للمواصفات القياسية .