LIPID OXIDATION AND QUALITY CHARACTERISTICS OF SOY-BUFFALO-PATTIES AS AFFECTED BY SORBIC ACID AND GAMMA IRRADIATION.

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INTRODUCTION:

The increasing consumption of ready-made foods and the interest in lipids and their relationship to health justify a closer look at the lipid consumption of different meat products (Sherck,1971 and Appledrof,1973).

Soy protein has a long history of usage by the meat industry(Rakosky,1974). The rising prices of meat protein have encouraged the development and introduction of new products derived from plant proteins(Ray et al,1981).

Although various workers have noted that tissue lipids were stable during frozen storage (Witt et al.,1970 and Bowers and Engler,1975),breakdown of triglycerides and phospholipids by lipases and autoxidation has been observed in frozen muscle tissue held at various temperatures and for different storage times(Keller and Kinsella,1973).

Control of lipid oxidation in meat and meat products has increased in importance with greater consumption of precooked meat items for both institutional and home use (Ingene and Pearson, 1979).

Irradiation as well as use of sorbic acid have been reported by different research workers for the inhibition of both microorganisms and enzymes in different meat products (Sofos et al.,1979 and Bhushan et al.,1981). However, the effect of sorbic acid on the meat constituents was not fully investigated.

Ground beef is a popular meat purchase, for it is one of the least expensive beef products available to the consumer (Mise,1977). Pietraszet (1975) has postulatedthat by 1980, 50% of beef slaughtered would be consumed as ground beef. Much of the ground beef research has been concerned with fat content. Glover(1968) showed that consumers discriminate against ground beef with high fat content because of excessive shrinkage and splattering during cooking, its implication as a cause of obesity, and its greasy taste. On the other hand, Cole et al. (1960) have earlier concluded that consumers preferred ground beef patties containing 35 to 45% fat.

This study was undertaken to: 1) Follow up the lipids oxidation (T.B.A., carbonyl compounds and phospholipids degradation) in soy buffalo meat patties using two fat levels i.e. 10 and 20%,during frozen stroage up to six months. 2) To evaluate the palatability characteristics of the patties as influenced by fat level, sorbic acid and gamma irradiation treatments. 3) To find out if precooking of buffalo meat patties before storage enhance their characteristics.

MATERIAL AND METHODS:

Deffatted soy flower(DSF)of Haro soy variety(obtained from the Agriculture Research Center,Giza),consisting of 49.5% crude protein and 1.2% extractable ether compounds was used in this study. After autoclaving at 108°C (5 Ibs/in²)for 20 minutes, to inactivate the trypsin inhibitor, and, just before use, the DFS was hydrated for 10 min. with 2 parts of water to 1 part soy flour by weight (Gardze et al.,1979).

Freshly trimmings of aged buffalo meat(from Cairo slaughter house) were visually differentiated into lean and fat groups and were separately ground through a 3 1/6 inch grinder plate.

Patties formulation:

The initial fat percentage of the ground lean meat was determined and adjusted upwards to 10 and 20% respec-

tively by incorporating ground buffalo fat. Rehydrated soy flower was then added as a replacement for 30% of the lean meat. The two buffalo patties formualtion were then formulated as follows:(1) 58.5% ground lean meat +10% fat +30% soy +1.5% salt.(2) 48.5% ground meat +20% fat +30% soy +1.5% salt. Each group was then reground for several times until a homogenous emulsion was obtained.

The two previous main groups were separately divided into six equal batches to cover the following treatments: 1. Raw buffalo patties +freezing(control). 2. Raw buffalo +0.2% sorbic acid+freezing. 3 Raw buffalo patties + γ-irradiation at 375 Krad + freezing. 4. Precooked buffalo-patties +freezing. 5. Precooked buffalo-patties +0.2% sorbic acid + freezing. 6. Precooked buffalo-patties + γ-irradiation at 375 Krad + freezing.

Addition for sorbic acid:

Sorbic acid was added to the buffalo formulation at the concentration of 0.2%(Yarceer and Gunduz,1980)in the water used for the rehydration of the soy flour to ensure its distribution.

Fabrication,packaging and storage:

The six ground buffalo batches were separately formed into 95 gm.patties with 5.2 cm diameter and a thickness of 1.7 cm. Either raw or precooked, each pattie was packed in a tight aluminum foil bag(12.5 cm.long,9.5 cm wide and thickness of 0.03 mm). Freezing was carried out in a deep freezer at-30°C±3°C for 48 hrs.,then held frozen at -10°C±2°C up to 6 months.

Cooking:

The previous batches, namely 4,5 and 6 were cooked at 75°C for about 45 minutes in a custum made gas oven preheated for 30 minutes at 177°C. Upon removal from the oven, samples were allowed to cool at room temperature for 15 minutes, then frozen and held in the frozen state.

Irradiation:

Irradiation was carried out using the cobalt 60 source of the National Center for Radiation Research and Technology, Nasser City. The system used was "Nortom Norcontral" Gamma cell indoor facility. Samples were irradiated from the frozen state by 375 Krad at a dose rate of 1-23 Krad/min.

Methods of analysis:

Lipids were extracted from the different treatment of the buffalo meat patties by the method of Floch et al., (1957). Total lipids content of the chloroform extracts was determined by the modified method reported by Knight et al.(1972). The colorimetric method of Keur et al.(1973) was employed for the quantitative determination of phospholipids. Thiobarbituric acid in the intact muscles was determined according to the method reported by Yu & Sinnhuber(1957), while total carbonyl compounds were determined by the method of Keller and Kinsella(1973).

Taste panel evaluation:

Raw samples were cooked as described before (at an internal temp.of 75°C),while precooked patties were reheated in an oven at 149°C to an internal temperature of 60°C for 10 minutes,according to Campbell and Mandigo (1978).Immediately after cooking or reheating,the samples were cut in halves so that the panelist's samples would have one outer and one internal surface exposed. Patties were warm served to semi-trained panelists of 20 members for evaluation. Preference ratings were made on a hedonic scale of 1 to 10 with one being "dislike extremely" and 10 "like extremely". The rating of 5,neither like nor dislike,was considered the base line for determining the acceptability of the product. Statistical analysis was performed on the data to determine the significant differences between the samples by using the analysis of variance and the L.S.D. test as reported by Waller and Duncan(1969).

RESULTS AND DISCUSSION:

I. Changes in the phospholipid fractions: The changes in the phospholipid fractions of soy-buffalo meat patties, as influenced by the different treatments i.e.sorbic acid, gamma irradiation,fat level,freezing and freezing storage,are presented in Fig.(1). The results clearly indicated that fat level added to the patties affected the phospholipids content. The percentage phospholipids in the patties with 20% fat was double that of the patties with only 10% fat. Meanwhile,samples containing sorbic acid or gamma irradiates did not show any alterations in their phospholipids content. It seems that irradiation at low dose rates (370 Krad) did not induce phospholipid degradation (Bhushan et al.,1981).

On the other hand, precooking revealed a more pronounced decrease in the phospholipids fraction of soy-buffalo meat patties(Fig.1). This decrease was more pronounced in the samples with 20% fat. This might be expected as with higher fat percentages such changes might be more indicative.

Oxidation of lipids during cooking has been reported by Chang et al, 1961 and Jakobsson and Berngtsson,1972. Keller and Kinsella(1973)indicated a small increase in the amount of lysophosphatidyl choline and lysophosphatidyl ethanolamine upon cooking of beef Hamburgers. Therefore, phospholipids degradation during cooking(Fig. 1) might be caused by phospholipases and/or selective thermal hydrolysis.

During frozen storage of buffalo meat patties, the phospholipids fractions decreased significantly regardless of the treatments used (raw or precooked,with 10 or 20% fat). After six months of storage the percentage reduction in raw and precooked samples reached 54% and 52% in case of 10% fat content and 49% and 53% with 20% fat content respectively. The results also indicated that both treatments i.e. sorbic acid and gamma irradiation, did not have any positive or negative influence on tne phospholipids degradation in soy-buffalo meat patties.

The loss of phospholipids during frozen storage might be caused by both enzymatic and oxidative reactions (Mai and Kinsella,1979). In the case of raw frozen patties, enzymatic reactions i.e. phospholipasses; are of significant effect (Audley et al.,1978). Meanwhile, in the cooked patties the degradation observed could be due to the residual phospholipasses or to the enzymatic oxidation. However, with the data available, it is not possible to ascertain whether enzymatic or oxidative reactions were the ones responsible for the decrease of phospholipids.

II. Changes in T.B.A. values and total carbonyl compounds: The oxidative rancidity(as T.B.A.values and total carbonyl compounds)of the soy buffalo meat patties in the different treatments under investigation is presented in Figures 2 & 3. The given results indicated that the fat level had no influence on the changes which took place in both T.B.A.values and total carbonyl compounds, as both samples with either 10 and 20% fat contents revealed almost the same rate of changes. On the other hand, sorbic acid treatment samples showed higher oxidative rates as compared with the control and gamma irradiated samples. Meanwhile, the gamma irradiated samples had higher T.B.A. values than the control ones. This might be due to the effect of gamma irradiation on lipids fraction leading to the formation of free radicals and,hence,released the aldehydes and increased the T.B.A. values (Cahmpagne and Nawar,1969).

The same results also showed that oxidative changes,as T.B.A.values and carbonyl compounds were more pronounced in the cooked samples than in the raw ones(Figs.2 & 3). However, sorbic acid treated samples still revealed the highest values especially in T.B.A. content. Zepser and Watts(1961) suggested that heme pigments might catalyze tissue oxidation and account for the increase in T.B.A. values and development of rancidity in cooked meat. Recently Ingene and Pearson(1979) clarified the role of myoglobin and ferrous iron by demonstra-

ting that cooking releases the iron from myoglobin and, thereby, indirectly accelerates development of autoxidation.

On the other hand, the T.B.A. values as well as the total carbonyl compounds tended to increase during frozen storage in all samples. However, the increase was clearly pronounced in samples treated with sorbic acid. It seems that addition of sorbic acid enhanced lipids oxidation and, hence, decreased the palatability characteristics as will be discussed later on. The role of sorbic acid in this respect is not quite clear.

Regarding the other treatments, the obtained results (Figs. 2 & 3) indicated that irradiated samples were similar in their T.B.A. values and carbonyl content to the control samples which might support the idea that irradiation at lower doses did not alter the lipids fractions drastically(Bhushan et al., 1981).

III. Taste-panel evaluation: Tables 1, 2 & 3 illustrate the mean values of the palatability characteristics including appearance, odor and flavor of raw and precooked soy-buffalo meat patties. Statistical analysis was condicted between the different treatments (i.e. sorbic acid treated samples and gamma irradiated samples with 10 and 20% fat), as well as between the different periods of storage (i.e. one, two, three, four, five and six months of storate at -10°C ± 2°C).

The obtained results indicated that fat level affected the acceptability scores of the soy-buffalo meat patties during storage. Samples with 20% fat ranked lower than those with only 10% fat and the difference was significant at the 95% confidence level after 3 months of storage (at -10°C ± 2°C). Meat aroma ($P < 0.05$) and flavour ($P < 0.01$) of freshly cooked buffalo meat patties scored higher than those of retreated patties. Generally, flavour and aroma decreased with increased fat level. The low acceptability of reheated patties might be due to the incidence of off-flavour and decrease of flavour desirability (Cross et al.,1979). It might be due, as well, to the increase of both T.B.A. values and total carbonyl compounds as has been discussed earlier.

Taste panel evaluation indicated that addition of sorbic acid (at 0.2%) had a significant deteriorative effect ($P < 0.01$) on the flavour scores of both raw-cooked or precooked-reheated soy-buffalo meat patties. However, the scores were significantly lower ($P < 0.05$) in the precooked-reheated samples.

On the other hand, samples treated with gamma irradiation at 375 Krad had the same consumer preference as the control in all appearance, flavour and odour. However, at zero time, irradiated samples ranked lower than the control ones, which could be mainly due to the direct effect of gamma irradiation on both flavour and odour. During frozen storage this effect diminished completely and the samples were insignificantly different from the control. Chipault and Mizano(1966) and Keskin (1977) reported similar findings with irradiated beef meat. Meanwhile, in the precooked samples, gamma irradiation had no positive or negative effects, as the acceptability scores were almost similar to the control ones.

During frozen storage up to six months, the acceptability of soy-buffalo meat patties were significantly ($P < 0.05$) altered. The changes were significantly ($P < 0.01$) clear in precooked samples than the raw ones, and in samples with 20% fat rather than in samples with 10% fat (Tables 1, 2 and 3) in all acceptability scores i.e. appearance, odour and flavour.

Meanwhile, the addition of sorbic acid enhanced the deterioration of acceptability (especially flavour) in precooked samples with 20% fat. Precooked reheated samples with added sorbic acid obtained significantly ($P < 0.01$) lower flavour scores only after one month of storage, whereas, their analogeous samples (i.e.control and gamma irradiated samples) reacted differently. At 10% fat level the flavour scores were significantly($P < 0.05$)

Table 1: Effect of Sorbic Acid and Gamma Irradiation on appearence scores of Soy-Buffalo meat patties.

Storage period	10% fat						20% fat						
	raw			precooked			raw			precooked			
	I	II	III	I	II	III	I	II	III	I	II	III	
Zero time	8.3	8.4	8.2	8.0	7.9	7.8	8.2	7.9	8.0	7.7	7.6	7.8	N.S. N.S.
15 days	8.2	8.2	8.1	7.9	7.9	8.0	8.1	8.0	8,1	7.6	7.5	7.7	N.S. N.S.
1 month	8.4	8.2	8.2	8.1	7.8	7.4	8.2	8.1	7.9	7.8	7.9	7.8	N.S. N.S,
2 months	8.3	7.9	8.1	7.8	7.8	7.9	8.0	7.8	7.9	7.7	7.6	7.6	N.S. N.S.
3 months	8.3	8.0	8.2	7.6	7.4*	7.4*	8.1	7.9	7.7	7.5*	7.3*	7.5*	0.7 N.S.
4 months	8.1	8.1	8.1	7.6	7.6	7.5	8.0	7.8	7.6	7.3*	7.3*	7.3*	0.7 N.S.
5 months	7.9	8.0	8.1	7.4*	7.3*	7.1**	7.8	7.7	7.6	6.9**	6.8**	6.7**	0.7 0.9
6 months	8.1	8.0	8.1	7.4	7.3*	7.3*	7.9	7.8	7.8	7.2*	6.8**	6.7**	0.8 1.1

* Significant at the 0.05 level.
** Significant at the 0.01 level.
I Control
II Sorbic Acid treated.
III Gamma Irradiated.

Table II: Effect of Sorbic Acid and Gamma Irradiation on odour Scores of Soy Buffalo meat Patties

Storage Period	10% fat						20 % fat						
	raw			precooked			raw			precooked			
	I	II	III	I	II	III	I	II	III	I	II	III	
Zero time	8.4	8.3	7.8	8.3	8.1	7.8	8.2	8.0	7.6*	8.1	8.1	7.7	0.6* N.S**
15 Days	8.5	8.3	8.0	8.2	8.2	7.9	8.2	8.1	8.0	8.0	7.9	7.9	N.S* N.S**
1 month	8.4	8.2	8.1	8.0	8.1	7.9	8.1	8.2	7.9	8.0	8.0	7.7*	0.5* N.S**
2 months	8.3	8.2	8.0	7.7	7.6	7.4*	7.9	7.7	7.8	7.5*	7.6	7.3*	0.8* 1.1**
3 months	8.0	8.1	7.8	7.4	7.5	7.4	7.7	7.5	7.5	7.2*	7.2*	7.0*	0.7* N.S.**
4 months	8.1	8.0	7.8	7.3	7.3	7.2*	7.6	7.5	7.6	6.9**	6.7**	6.9**	0.9* 1.2**
5 months	7.8	7.6	7.5	7.0*	7.1*	6.8 **	7.3	7.3	7.3	6.4**	6.5**	6.2**	0.6* 1.0**
6 months	7.6	7.4	7.6	6.6**	6.7*	6.7*	7.1	7.0	7.0	6.1**	6.2**	6.3**	0.8* 1.0**

* Significant at the 0.05 level
** Significant at the 0.01 level
I Control
II Sorbic Acid Treated
III Gamma Irradiated

Table III: Effect of Sorbic Acid and Gamma Irradiation on Flavor Scores of Soy Buffalo meat Patties.

Storage Period	10% fat						20% fat						
	raw			precooked			raw			precooked			
	I	II	III	I	II	III	I	II	III	I	II	III	
Zero time	8.5	7.9	8.1	7.9	7.5*	7.9	7.9	7.8	7.9	7.8	7.6*	7.8	0.7* ** N.S.
15 Days	8.3	8.0	8.2	7.7	7.3	7.8	8.0	7.7	8.0	7.8	7.3	7.8	0.7* N.S.**
1 month	8.1	7.8	7.9	7.5	7.0*	7.4	7.8	7.5	7.6	7.3	6.9*	7.3	0.9* N.S.**
2 months	8.2	7.5	7.7	7.4	7.1*	7.4	7.7	7.3	7.5	7.1*	7.0*	7.1*	0.9* N.S.**
3 months	7.8	7.6	7.8	7.5	7.0*	7.2*	7.7	7.1*	7.6	7.1*	6.8**	6.9**	0.6* 0.9**
4 months	7.6	7.4	7.5	7.1	6.5*	6.9	7.5	7.0	7.4	6.9	6.3**	6.7*	0.8* 1.2**
5 months	7.3	7.3	7.3	6.5*	6.3**	6.4**	7.2	6.9	7.3	6.4**	6.0**	6.3**	0.7* 0.9**
6 months	7.2	7.0	7.1	6.5*	5.6**	6.3*	6.9	6.9	6.8	6.0*	5.4**	5.8**	0.6* 1.0**

* Significant at the 0.05 level.
** Significant at the 0.01 level.

I. Control

II. Sorbic Acid treated.

III. Gamma Irradiated

lower after 5 months of storage, while, at 20% fat level the scores were significantly (P 0.05)lower after only 3 months of storage. On the other hand, all raw frozen (freshly cooked) samples at the 10% fat content level, were insignificantly affected in all acceptability scores even after 6 months of storage(except for those treated with sorbic acid).

Hence, it might be concluded that:

1. Addition of sorbic acid, although decreases the microbial load of soy-buffalo meat patties, but it significantly alters adversely the acceptability scores especially in case of high fat levels in the patties.
2. Frozen storage for long periods (i.e. 6 months), are not recommended for the precooked soy-buffalo meat patties, as this enhances lipids oxidation and consequently affects the acceptability scores.
3. With high fat levels, soy-buffalo meat patties has to be stored in the raw state rather than cooked in order to maintain their palatability characteristics.

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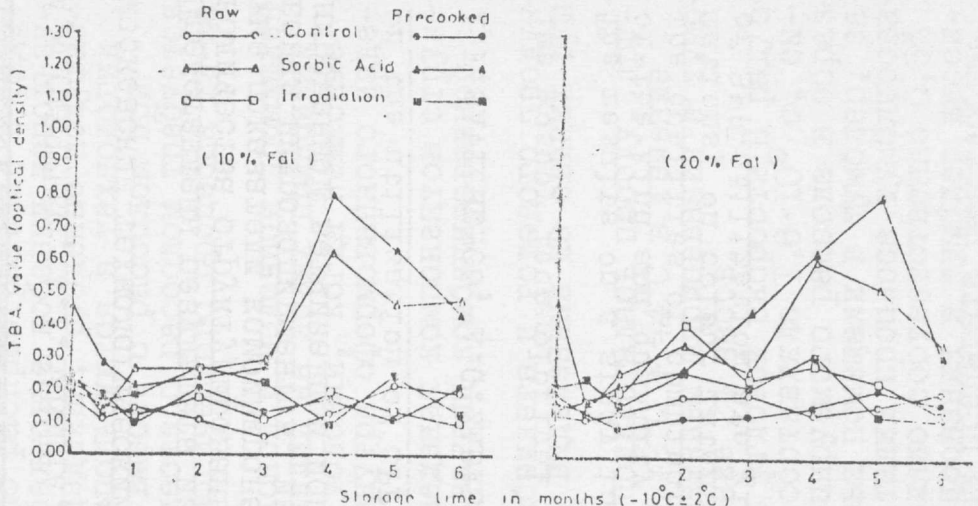

Fig.(2) Effect of sorbic acid and gamma irradiation on thiobarbituric acid (optical density) of soy_buffalo meat patties .

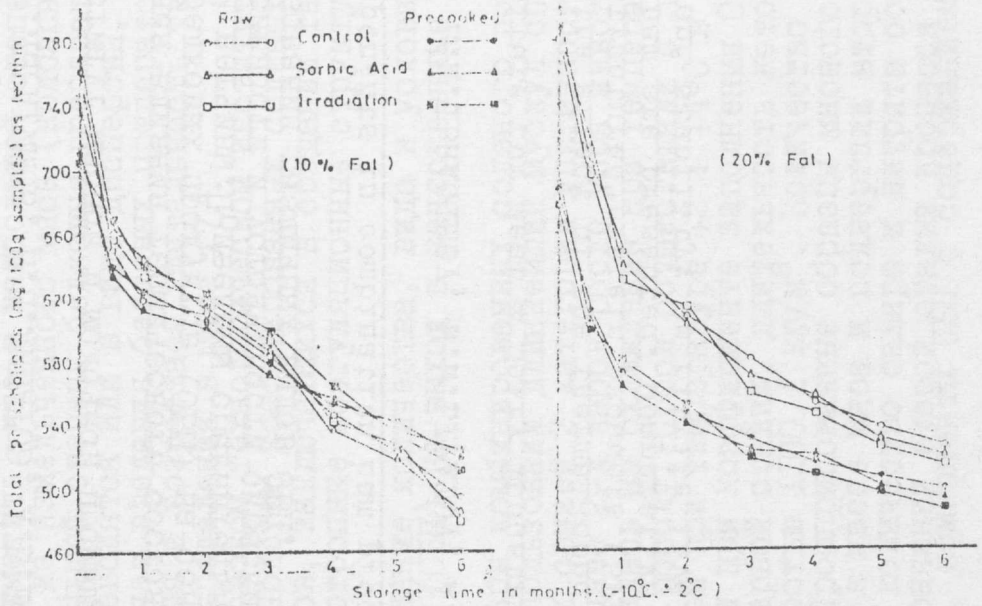

Fig.(1) Effect of sorbic acid and gamma irradiation on phospholipids degradation of soy_buffalo meat patties .

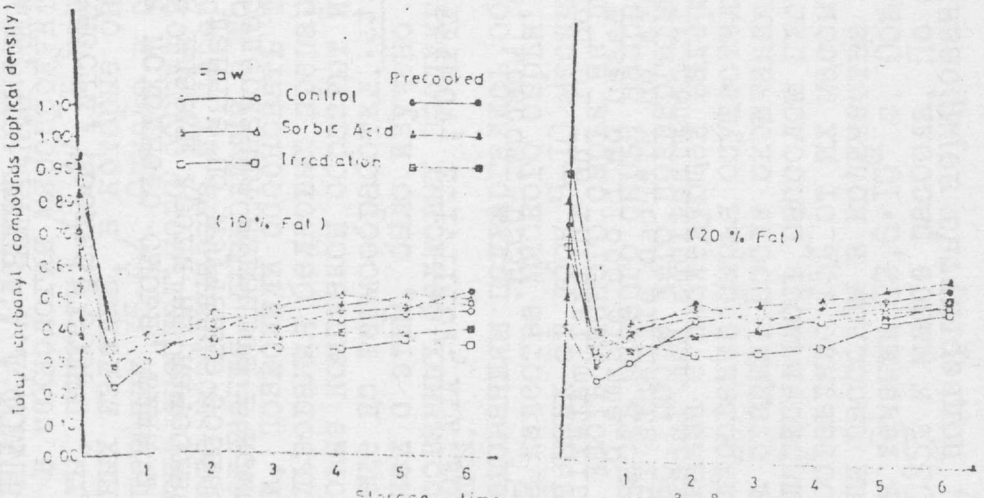

Fig.(3) Effect of sorbic acid and gamm irradiation on total carbonyl compounds of soy_buffalo meat patties .