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EFFECT OF STORAGE CONDITION ON THE CHEMICAL PROPERTIES OF PORK BACON

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Abstract:

In this work some chemical properties such as water, fat and nitrogen content, 2-thiobarbituric acid and peroxide numbers, free fatty acids, melting point, iodine, saponification numbers and rancidite were studied in bacon, both in the fresh condition and after storage at —18 ± 1°C for up to 60 days. The effect of vacuum packaging versus non-packed storage, was also determined. Some quality criteria of the bacon or bacon fat were determined.Overall results indicated that both the bacon or bacon fat can be effectively used in various types of food and food processing, especially after performing some technological and refining processing. If the bacon has to be stored, it should be vacuum packed and stored frozen. At —18°C, vacuum-packed bacon samples could be stored around 45 days, but in the netting bags, this storage period should not exceed 30 days.

Key words: pork bacon, chemical properties**,** TBA test, unpacked, vacuum-packed.

INTRODUCTION

Bacon is a cut of meat taken from the sides, belly, or back of a pig, and then cured, smoked, or both. Bacon, or bacon fat, is often used for barding and larding roast fowl and game birds, especially those that have little fat themselves. The bacon itself may afterwards be discarded or served to eat, like crackling. Bacon fat liquifies and becomes bacon dripping when it is cooked. Once cool, it firms into lard. Bacon fat is flavourful and is used for various cooking purposes. Traditionally, bacon grease is saved and used as a base for cooking and as an all-purpose flavouring, for everything.

However, despite this wide usage, there has been no detailed work done on the nutritive value, nor on the physical or chemical quality criteria, of the bacon or the bacon-fat.

Very limited work has been done on the proximate analyses, and on the quality parameters, of bacon. The average melting point (MP) of bacon fat has been determined as 34-48°C. Acid number 1.30-1.45 mg KOH/g fat and free fatty acid (FFA) value, as oleic acid, 0.65-0.73%.

As it is widely known, during the storage of the fat and fatty products (depending upon the storage conditions) some degree of deterioration occurs (Frankel, 1991). Fat deterioration proceeds hydrolytically and autoxidatively and many complex reactions can take place. Due to these complex reactions, physical and chemical characteristics of the fat, such as, melting point (MP), iodine number

(IN), saponification number (SN), free faty acid value (FFA), peroxide and 2-thiobarbituric acid (TBA) values can change, and these factors play a very important role in the nutritive and the quality criteria of the fatty products (Hamilton, 1989).

The objective of this experiment was to determine and evaluate some nutritive and quality criteria of the bacon and bacon-fat, in fresh condition and after periods of frozen storage. An experiment was conducted to measure the differences between unpacked bacon-fat, that is without any protection, and bacon-fat which was vacuum packed.

MATERIAL AND METHODS

The laboratory examination was performed at the "Research Center of the Risk Factors for Agriculture, Forestry and Environment" in the Faculty of Environmental Protection, University of Oradea in 2009.

Physical-chemical analysis was performed on five samples of bacon, each weighing around 500g, after 0, 30, 45 and 60 days of storage, at 2 to 4 °C, unpacked bacon (series A) and under vacuum-packaging (series B). For vacuum packaging a vacuum of 22-24 in Hg was applied and the bags were heat sealed automatically. For non-packed samples, the neck of the netting bags was tied with a piece of string. Both samples were placed in a laboratory-type freezer. Analyses were done in duplicate samples at 0, 30, 45 and 60 days of storage.

Physical-chemical parameters were analyzed according to the official methods of analysis of AOAC international (Horwitz, 2000):

- The water content was determined by drying the meat in a forced draft oven at 105°C;
- Protein contents was determined by Kjeldhal method, using a digestion unit, a distilling unit, calculating the total nitrogen content (N%), and conversion of N% in protein multiplying by the conversion factor of 6,25. This method are based on nitrogen determination
- Fat substances determined with Soxhlet method; fat is extracted with an organic solvent (petroleum ether), in a Gerhard Soxtherm.

For spectrophotometrical determination we used UV-Visible mini–1240 Shimadzu spectrophotometer at 520 nm wavelength.

TBA analysis was also carried out on bacon fat by using the method described by Pensel (1990).

For the other analyses, the bacon sample was cut into small pieces with a sharp knife, put into a lidded glass jar and melted on a hot plate at around 180°C. Melted fatty tissue was filtered through a clean muslim cloth. From the filtrate, samples were taken for the following analyses: MP, as °C (AOAC, 2000), IN as g iodine/100 g fat, FFA percent, as oleic acid, and peroxide number (PN) as the meq O_2/kg fat, were determined as

outlined by Deatherage (1977). The SN (mg KOH/g fat) was determined as described by Dogan and Basoglu (1985).

RESULTS AND DISCUSSION

Overall results obtained from the bacon and fat are given in Table 1. Fat content slightly increased and the water content decreased during the storage.

Tabel 1

Estimative mean values for Water, Fat and Protein contents, values determined in non-packed or vacuum packed bacon fat samples

Parameters (mean value ± standard deviation)	**Storage period (days)**						
	0	**30**		**45**		**60**	
	fresh samples	**Non-packed**	**Vacuum packed**	**Non-packed**	**Vacuum packed**	**Non-packed**	**Vacuum packed**
Water content (%)	43.38 ± 0.63	41.04 ± 0.61	42.85 ± 0.59	38.19 ± 0.58	40.69 ± 0.62	34.32 ± 0.6	38.27 ± 0.65
Total fat content (%)	42.65 ± 0.81	44.85 ± 0.8	43.05 ± 0.82	47.96 ± 0.74	45.35 ± 0.79	51.68 ± 0.75	47.73 ± 0.83
Protein content (%)	9.62 ± 0.27	9.02 ± 0.25	9.65 ± 0.21	9.34 ± 0.22	9.72 ± 0.23	9.43 ± 0.19	9.56 ± 0.24
TBA number (mg malonaldehyde /kg fat)	1.32 ± 0.05	1.93 ± 0.05	1.83 ± 0.06	2.95 ± 0.06	2.33 ± 0.06	3.05 ± 0.05	3.55 ± 0.06
Peroxide number (PN) (meq O_2/kg fat)	0.58 ± 0.03	1.59 ± 0.03	1.46 ± 0.03	2.82 ± 0.02	2.29 ± 0.02	3.63 ± 0.03	3.76 ± 0.03
FFA (%)	0.18 ± 0.01	0.17 ± 0.01	0.18 ± 0.01	0.21 ± 0.01	0.30 ± 0.01	0.28 ± 0.01	0.32 ± 0.01
Melting point (°C)	34.9 ± 0.12	34.9 ± 0.12	35.0 ± 0.12	35.6 ± 0.12	36.0 ± 0.12	35.9 ± 0.12	35.9 ± 0.12
Iodine number (IN) (g iodine/100 g fat)	48.4 ± 0.71	53.35 ± 0.69	53.65 ± 0.72	47.38 ± 0.73	48.98 ± 0.7	51.9 ± 0.68	49.80 ± 0.67
Saponification number (SN) (mg KOH/g fat)	180 ± 1.21	170 ± 1.33	195 ± 1.2	180 ± 1.28	201 ± 1.25	185 ± 1.21	188 ± 1.22

*Data are presented as mean ± SD (n=3)

The high fat content found indicates that bacon is a concentrated fat source. The water content of the bacon decreased to some degree. Protein content did not change during the storage either of the samples kept unpacked or of those which were vacuum packed These results could be explained as being due to variations of the other components of the bacon tissue during storage. Compared with many other food products, the total nitrogen content of the bacon is lower. Consequently, the bacon is not considered to be a rich nitrogen or protein source.

In Tabel 2. variance analyses results of water, fat and protein % values of the tissue are given. At the beginning of storage, water content decreased more rapidly in the unprotected, netting bag samples

than in the vacuum-packed ones and the fat content increase in unprotected samples in comparison with the vacuum-packed. The protein content decreased or increased non-sifnificant in both of experimental series – unpacked or vacuum-packed.

Tabel 2

Variance Analyses Results of Water, Fat and Protein content of non-packed or vacuum packed bacon fat samples, in comparison with fresh samples.

		Water%		*Fat %*		*Protein %*	
Variation source / *Nr. of days*		*Degrees of freedom*	*Statistical significance*	*Degrees of freedom*	*Statistical significance*	*Degrees of freedom*	*Statistical significance*
Non packed	30	8	***	8	***	8	ns
	45	8	***	8	***	8	ns
	60	8	***	8	***	8	ns
Vacuum packed	30	8	ns	8	ns	8	ns
	45	8	***	8	***	8	ns
	60	8	***	8	***	8	ns

p>0,05= non-significant; p<0.05= * significant; p<0.01=** distinctly significant; p<0.001=*** very significant in comparison with the control lot

Tabel 3

Variance Analyses Results of PN, TBA, FFA, MP, IN, SN of non-packed or vacuum packed bacon fat samples, in comparison with fresh samples.

		PN (meqO_2/kg fat)	*TBA (mg MDA /kg fat)*	*FFA Oleic acid %*	*Melting point (°C)*	*IN (g I_2/100 g fat)*	*SN (mg KOH/g fat)*
Variation source / *Nr. of days*		*Statistical significance*					
Non packed	30	***	***	ns	ns	***	***
	45	***	***	***	ns	*	ns
	60	***	***	***	ns	***	***
Vacuum packed	30	***	***	ns	ns	***	***
	45	***	***	***	ns	ns	***
	60	***	***	***	ns	**	***

p>0,05= non-significant; p<0.05= * significant; p<0.01=** distinctly significant; p<0.001=*** very significant in comparison with the control lot

In Tabel 3. variance analyses results of TBA numbers, peroxide number (PN), FFA, MP, IN and SN are given.

PN always increased in both samples from the fresh bacon, toward the end of the storage period, as did the TBA values. This increase occurred more slowly in the vacuum-packed samples at around 30 and 45 days of storage, but, it reached, and even passed, the value of the netting bag samples at 60 days of storage (Fig.1). During the shorter period of storage, vacuum packaging protected the bacon against autoxidation

and kept the PN at lower values, but when the storage period was lengthened, this effect was lost.

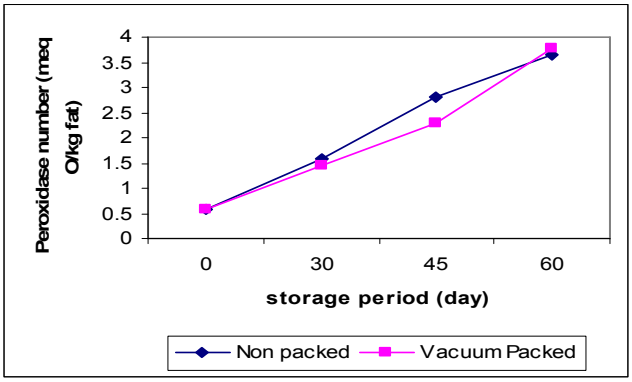

Fig. 1. Peroxide numbers of bacon samples in netting bags and vacuum packs during 60 days of frozen storage.

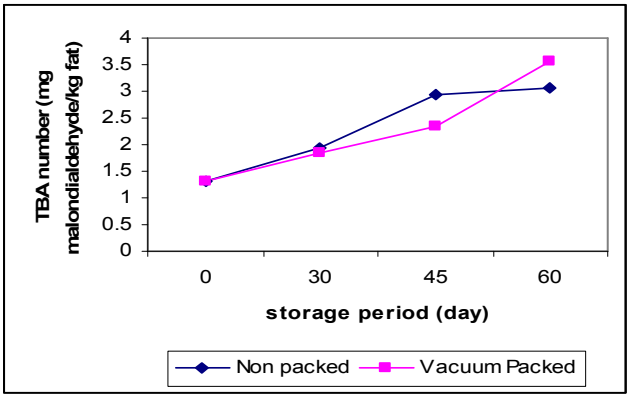

Fig. 2. TBA values of bacon samples during 60 days of storage in netting bags and vacuum Packs

The TBA numbers for the vacuum-packed samples reached higher values than the netting bag samples after 60 days of storage (Fig.2). This result could be expected (and explained) by the slower rate of autoxidation of unsaturated fatty acids in the vacuum-packed samples during the early period of storage. Autoxidation progressed much faster in the unprotected samples, during the early storage periods, and so, a higher amount of malonaldehyde accumulated and the TBA numbers reached higher values. Since, malonaldehyde is not stable for a longer period, and is oxidised to secondary oxidation products, the total amount of oxidisable unsaturated bonds decreased. So the TBA values first reached higher values, then peaked and, thereafter, started to decline to some degree. In the vacuum-packed samples, the peak TBA numbers may not yet have been reached after

60 days of storage. If the storage period had been lengthened, a noticeable decline could have been detected in the TBA values of both packaging types. Similar results for the TBA values had been observed in the longer period of frozen stored meat products, and led to a similar interpretation (Gokalp *et al.,* 1983).

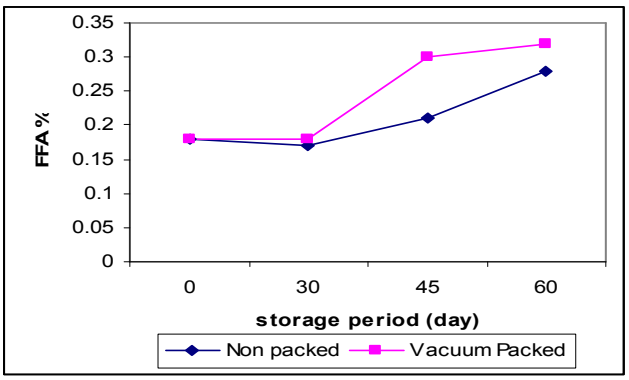

Fig. 3. FFA values of bacon samples during 60 days of storage in netting bags and vacuum Packs

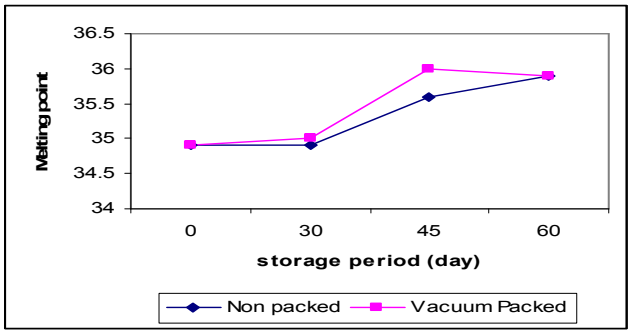

Fig. 4. MP values of bacon samples during 60 days of storage in netting bags and vacuum Packs

Vacuum-packed samples always gave higher FFA values than the other samples. In all the samples, FFA values increased during storage (Fig.3). In general, the FFA values of bacon are not very different from the FFA level permitted in other food type.

In Fig 4 it was shown that the MP of the fresh bacon increased during the storage period. This increase could be the result of the increasing ratio of saturated fatty acids during storage, because of the autoxidation of the unsaturated fatty acids (Frankel, 1991). In fact, variance analysis results on the MP values found in this research indicated that the storage period had a highly significant effect (Table 3).

Determined MP values were similar to, or little lower or higher than, the MP of the bacon of different pork species, as previously determined in other research work(Sengonca and Sancan, 1974; Biyikoglu, 1977; Sancan, 1979).

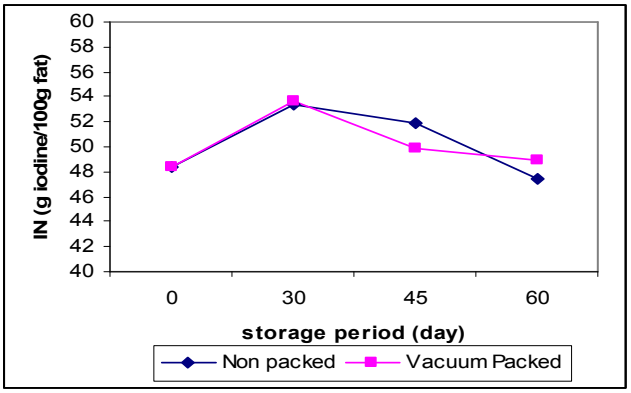

Fig. 5. IN values of bacon samples during 60 days of storage in netting bags and vacuum Packs

Lower values of IN can be explained as due to the relatively higher concentration of the saturated and monounsaturated fatty acids content of the bacon. During the storage period, the IN of the samples decreased noticeably. Variance analyses results indicated (Table 3) that the storage period and the interaction of the storage period and packaging method had a highly significant effect on the IN (Fig.5). During storage, autoxidation of the polyunsaturated fatty acids generally occurs, and so a relative increase in the saturated fatty acid content could reduce the IN toward the end of the storage.

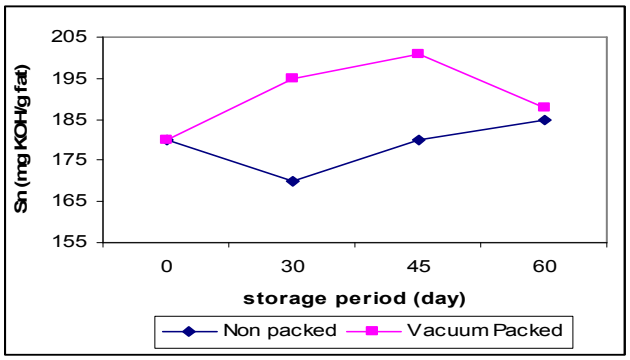

Fig. 6. Saponifikation numbers of bacon-fat samples in netting bags and vacuum packs during 60 days of frozen storage.

Saponification numbers of the fresh bacon showed a decreasing

trend as the storage period increased (Table 1 and 3). A significant interaction effect of the treatments was shown in Fig. 6. Probably, the higher lipolytic deterioration rate of the fat in the netting bags resulted in higher FFA content. This higher FFA content could have caused a higher K binding by a gram of fat, thereby producing the higher SN. But, after a certain period of storage, the accumulated FFA would have been oxidised into secondary oxidation products, such as aldehydes, ketones etc. and the SN would have started to decline.

CONCLUSION

Overall results indicated that the bacon is an important and concentrated fat source. If the pork bacon has to be stored for some period, it should be vacuum packed and stored frozen because, it will deteriorate in cold storage rooms of between 4 and 10°C, regardless of whether it is in netting bags or vacuum packed. The maximum storage period at 4-10°C of bacon kept in netting bags, (that is without any protection) should only be for around 30 days. For the vacuum-packed samples, this maximum frozen storage period should be around 45 day. It is necessary to carry out further detailed technological research work on the pork-bacon.

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