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CHEMICAL PRESERVATION OF BLOOD INTENDED FOR FEEDING PURPOSES

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INTRODUCTION

Blood from slaughtered animals, often called "a liquid tissue", has a composition similar to lean muscle tissue, with respect to the protein and the amino acid contents. Unlike muscle tissue,there are no ageing processes in blood post-mortem. The pH of blood remains high and it is an ideal medium for the growth of microorganisms, particularly the proteolytic species. When stored in slaughterhouses or in further processing premises blood deteriorates rapidly, because of the rapid multiplication of the micro-flora. The first symptoms of blood deterioration can be recognized sensorially after only six hours of storage.

For the preservation of slaughter blood there are both physical and chemical methods employed to preserve blood before it is prepared for feeding purposes (Budig, 1990). Chemical methods are simpler and cheaper than the physical methods. Chemically preserved blood can be further processed, or used directly as a fodder for domestic animals, pigs and poultry in particular.

As early as 1968, the Meat Industry Research Institute (VUMP) in Brno was studying the preservation of blood intended for feeding (Vrchlabsky, 1968). Those studies were continued in 1984 (Dvorak, 1985), and the findings were introduced for practical use in 1990. The results of those investigations are presented in this paper.

MATERIALS AND METHODS

We have selected sodium disulphate ($Na_2S_2O_5$ in 0.5% and 1% concentrations) after having examined various other preserving compounds, e.g., allylisothiocyanate, ammonia, urea, sodium fluoride, and some organic and inorganic acids.

The blood samples were stored at temperatures of 2, 20 or 30°C and were evaluated sensorially. The samples were examined for the presence of various pathogenic bacteria, and the concentrations of hydrogen sulphide were determined.

The second part of the experiment studied the effects of 1% sodium disulphate with either 0.91% hydrochloric acid, 1.25% sulphuric acid, or 1.15% formic acid, on non-sporing and sporing microorganisms, and on some viruses.

In the third part of the experiment the blood was preserved with 1% sodium disulphate and 0.91% hydrochloric acid (36% w/v). The preserved blood was mixed into feeds for pigs. Altogether 2,482 pigs were evaluated with starting weights of about 28kg. The control and experimental groups respectively contained 1247 and 1235 animals. Both groups of animals were fed identical amounts of digestible nitrogenous matter. The average feeding period in the control group was 165 days, and in the experimental group 162 days. Both groups were evaluated with respect to fattening performance and slaughter yield. The muscle tissue pH was measured 45 minutes after slaughter to detect carcasses of PSE character. Meat from the animals was tested sensorially.

RESULTS AND DISCUSSION

The results in Tables 1 and 2 show that blood preserved with 1% sodium disulphate can be stored at 2°C or 20°C for 14 days, or at 30°C for 10 days, with no risk of decay. Thus, preservation with 1% sodium disulphate significantly extends the storage life of blood. Sodium disulphate is a suitable preservative of slaughter blood that is intended for further processing, as in drying to blood meal.

The combinations of sodium disulphate with either hydrochloric acid, sulphuric acid, or formic acid was effective for the preservation of blood for pig feeds. Table 3 shows that these chemicals acted as bactericides on non-sporogenic microorganisms. The results summarized in Table 4 demonstrate that the combination of sodium disulphate (1%) and hydrochloric acid (0.91%, 36% w/v) had a bactericidal effect on vegetative forms of *bacillus cereus* (collection strain CCP 5631), and on spores at the certain stage of sporulation. The blood samples stored over a longer period showed a moderate decrease in the numbers of spores of *bacillus cereus*, which demonstrated that the preserving agents acted bacteriostatically, or slightly bactericidally. Further cultivations and tests were carried out in guinea pigs, rabbits, chickens and pigs, in order to find out the effect of the combination of preservatives on *mycobacterium tuberculosis* var. *bovis* and var. *avium* and on the viruses causing Morbus Aujeszky disease, and Swine fever. Again, the preservatives showed significant bactericidal and viricidal effects. From these results, the blood preserved with sodium disulphate and hydrochloric acid could be considered as "commercially sterile", and so suitable for feeding domestic animals, primarily pigs.

The feeding experiments showed very good results. The average daily live weight gain was 601g in the control group, and 614g in the experimental group. The feed consumption per 1kg live weight gain in the experimental group was lower by 0.28kg, while the weight of the daily ration was 0.13kg than the control group.

The slaughter yields showed no significant differences between the experimental group and the control group. The values of average weight of boned carcasses (106.3kg), the market price, the price per 1kg meat, and the price per carcass were the same. Cutting yield was better in the experimental group, which showed a fat content lower by 2.5% and a higher content of lean meat than in the control group. Quality tests of carcass halves revealed the occurrence of 21% of PSE meat in the control group, and 15% in the experimental group. Economic evaluations of the feeding test showed that feeding costs per animal in the control group were lower by 256.89CSK (Czech Crowns), the expenses per 1kg live weight gain were lower by 2.42 CSK and the expenses per one day of feeding were lower by 1.33 CSK than in the test group.

The addition of sodium disulphate and hydrochloric acid to blood releases sulphur dioxide, which irritates the respiratory tract and conjunctiva of the personnel. A closed mixing system has therefore been built. After blending with preservatives, the blood is packed either in disposable polyethylene bags or in recyclable plastic tanks. The equipment can process 2,000 or more litres of blood per hour. The blood packed in bags and tanks coagulates within 15 to 20 minutes, then agglutinates and turns into a dark brown firm paste. The preserved blood sealed in containers can be stored over a long period. Samples kept at room temperature for approximately six months were sensorially and microbiologically unspoilt. Preserved blood is soluble in water, highly digestible, and suitable for use in liquid and mush feeds for slaughter pigs.

CONCLUSION

Blood intended for use as animal feed can be preserved with sodium disulphate (1%), and stored at 2°C or 20°C for 14 days, or at 30°C for 10 days without spoiling. The blood can be then further processed, principally by drying into blood meal.

The final product is prepared by the addition of 1% sodium disulphate and 0.91% hydrochloric acid (36% w/v) to the slaughter blood. This product is "commercially sterile" and can be mixed into the feed for slaughter pigs. The preservatives have a bactericide effect on non-sporogenic microorganisms, and a strong viricidal effect. The preserved blood proved satisfactory for feeding slaughter pigs. The addition of the preserved blood had a positive effect on daily

live weight gains, and on feed consumption per 1kg live weight gain. The pigs provided with the enriched ration had a lower fat content, higher yield of meat and a less frequent occurrence of PSE meat than the control group.

For industrial purposes it was necessary to design a closed mixing system, to avoid adverse effects on the workers health. The blood packed into polyethylene bags or plastic tanks can be stored for long periods of time. The preserved blood has a firm pasty consistence and is soluble in water.

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Table 1. Microbiological and sensorial examination of blood preserved with 1% of $Na_2S_2O_5$ and stored at 2, 20 and 30°C.

Blood sample Temp (°C)	Total content of pathogens in 1ml after 24h	48h	72h	7d	10d	14d
Control						
2	10^6	10^5	10^5	10^5		
20	10^6	≡				
30	10^6	≡				
0.5% $Na_2S_2O_5$						
2	10^2	10^3	10^3	10^3	10^3	10^4
20	10^3	10^5	10^6	≡		
30	10^3	10^7	≡			
1.0% $Na_2S_2O_5$						
2	10	10	10	10	10	10
20	10	10	10^2	10^4	10^5	10^5
30	10	10	10^2	10^5	10^6	≡

Table 2. Chemical (qualitative H_2S) and sensorial examination of the blood preserved with 1% of $Na_2S_2O_5$ and stored at 2, 20 and 30°C.

Blood sample Temp (°C)	H_2S after blood storing for 24h	48h	72h	7d	10d	14d
Control						
2	neg	neg	neg	neg	neg	neg
20	neg	+++	≡			
30	neg	+++	≡			
0.5% $Na_2S_2O_5$						
2	neg	neg	neg	neg	neg	neg
20	neg	neg	neg	neg	neg	++
30	neg	++	≡			
1.0% $Na_2S_2O_5$						
2	neg	neg	neg	neg	neg	neg
20	neg	neg	neg	neg	neg	neg
30	neg	neg	neg	neg	neg	neg

Legend to Tables 1 and 2:

≡ = sensorially spoiled, no further tests
neg = negative finding of H_2S
++ = medium formulation of H_2S
+++ = strong formation of H_2S

Table 3. Effect of $Na_2S_2O_5$ and of some acids on collection of microorganism strains (at room temperature).

Microorganism	$Na_2S_2O_5$ + HCL		$Na_2S_2O_5$ + H_2SO_4		$Na_2S_2O_5$ + HCOOH	
	48h	96h	48h	96h	48h	96h
Escherichia coli	-	-	-	-	-	-
Slamonella cholerae suis	-	-	-	-	-	-
Pasterella multocida	-	-	-	-	-	-
Brucella sius	-	-	-	-	-	-
Staphylococcus aureus	-	-	-	-	-	-
Streptococcus agalactiae	-	-	-	-	-	-
Listeria monocytogenes	-	-	-	-	-	-
Erysipelotrix rhusiopathia s.	-	-	-	-	-	-
Bacillus cereus	++++	++++	++++	++++	++++	++++
Bacillus subtilis	+++	+++	+++	+++	++	+++
Clostridium septicum	+++	+++	+++	+++	++	+++
Clostridium sporogenes	+++	+++	++	+++	+++	+++

Legend: - = negative growth
++ = cultivation of less than 50 colonies
+++ = cultivation of less than 100 colonies
++++ = cultivation of more than 100 colonies

Table 4. Effect of $Na_2S_2O_5$ and HCl on *bacillus cereus* -- quantitative examination of vegetable cells and/or spores content in 1ml o l g (at room temperature).

Storage time	Vegetable cells and spores		Spores			
	serum	blood	serum cont'l	test	blood cont'l	test
24 hours	$3.8x10^3$	$1.7x10^3$	2.0×10^5	10	4.3×10^3	3.2×10^2
48 hours	$3.6x10^3$	$1.7x10^3$	4.5×10^5	-	4.3×10^3	3.2×10^2
96 hours	$3.8x10^3$	$1.5x10^3$	6.4×10^5	-	4.8×10^3	2.5×10^2
7 days	$3.4x10^3$	$2.0x10^3$	7.2×10^5	-	3.0×10^3	2.4×10^2
14 days	$3.0x10^3$	$2.0x10^3$	8.0×10^5	-	3.0×10^3	7.0×10
21 days	$2.8x10^3$	$1.8x10^3$	8.0×10^5	-	3.0×10^3	8.0×10
28 days	$2.8x10^3$	$1.5x10^3$	7.4×10^5	-	3.0×10^3	6.0×10