E24

PARTICLE SIZE OF THIN FILM DRIED PORCINE BLOOD PLASMA RELATED TO COLOR, SOLUBILITY, PROTEIN CONTENT AND DRY MATTER

M. B. NYGAARD, Ph.D.-STUDENT AND K. P. POULSEN, PROFESSOR h.c. (P.R.C.)
Department of Biotechnology, Building 221, Technical University of Denmark, DK-2800 Lyngby, Denmark
(Edidan, Moelhavevej 12b, DK-9440 Aabybro, Denmark) E-mail address: mbn@ibt.dtu.dk

KEYWORDS: Porcine plasma, thin film dried plasma, particle size, color, solubility.

OBJECTIVE

The objective of the present work has been to examine whether dark color and low solubility are related to a certain size of particles in TFM plasma, and if so whether it is possible to improve overall solubility and/or color by removing a specific fraction of the particles.

BACKGROUND

When dealing with porcine blood plasma for human consumption, health regulations require that plasma should be kept at a maximum of 3°C for no longer than 4 days. Within these time and temperature limits the plasma should be further processed to a form that will prevent growth of microorganisms. Drying is a way to meet this requirement and especially spray drying of plasma has been carefully studied. An alternative to spray drying is thin film drying (TFM) in which plasma is sprayed on plastic spheres (d ~ 20 mm) circulating in a tower. Hot air is passing the spheres with an inlet temperature of 90°C and an outlet temperature of 45°C. The time of residence for plasma in the tower is 15-20 minutes and after this dried plasma leaves the tower through an outlet in the bottom as a consequence of the spheres rubbing against each other during circulation. Thin film drying results in a less voluminous and less dusty plasma powder than spray drying. However TFM plasma tends to be darker and have a lower solubility than spray dried plasma, and ways to avoid or compensate for these disadvantages may therefore be valuable.

METHODS

Sample preparation. 5 kg of TFM porcine plasma was sifted in portions of 100 g. Each portion was sifted for 10 minutes on an ELM-shaking screen using ASTM-sieves with mesh no. 50, 60, 70, 100, 140 and 270 resulting in 7 fractions (table 1). After sifting, fractions containing the same range of particle size were pooled and stored in plastic bags at 2°C until used.

Dry matter. 2 g of powder was transferred to a small beaker (d = 33 mm), dried in an oven at 105°C for 18 hours and cooled in an exicator. Each sample was analyzed in triplicate.

Protein content. A standard Kjeldahl method was used (1,5 g K_2SO_4 + 7,5 mg Se as katalyst) . Analyses were carried out in duplicate.

Color. The color was measured using a Minolta Chroma Meter CR-200. The sample to be measured was transferred to a petridish and the color was measured through the bottom of the dish. For each sample 9 measurements were made. The results are reported in the color space L*a*b* (CIELAB).

Fraction no.	1	2	3	4	5	6	7
Particle size/ mm	< 0,053	0,053-0,106	0,106-0,150	0,150-0,212	0,212-0,250	0,250-0,300	> 0,300
Weight %	2,7	38,9	48,8	6,7	1,1	0,6	1,2

Table 1. Distribution of particle size

Solubility. Total solubility (TS) as well as protein solubility (PS) were determined as follows. 50 ml of distilled water was added to 0,5 g of plasma powder. The suspension was placed on a magnet stirrer and adjusted to pH 7,0 using 0,1 M HCl. After 10 minutes pH was readjusted and the suspension was stirred for another 35 minutes at room temperature. During stirring the suspension was covered to avoid evaporation. The suspension was centrifuged at 25.800 G for 15 minutes and filtered through a Whatman filter no. 4. The filtrate as well as the initial powder were analyzed for protein and dry matter.

RESULTS AND DISCUSSION

Distribution of particle size and water content are shown in table 1 and figure 1 respectively. Almost 90 % of the particles has a size between 0,053 and 0,150 mm and 1,2 % of the particles exceeds 0,300 mm (table 1). The two bulk fractions, no. 2 and 3, has the lowest water content, while the rest of the fractions have water contents 0,4 - 1,2 % higher. Allthough there is a statistical significant differens in water content between fractions ($p < 0,1$), there is no simple relation between particle size and water content.

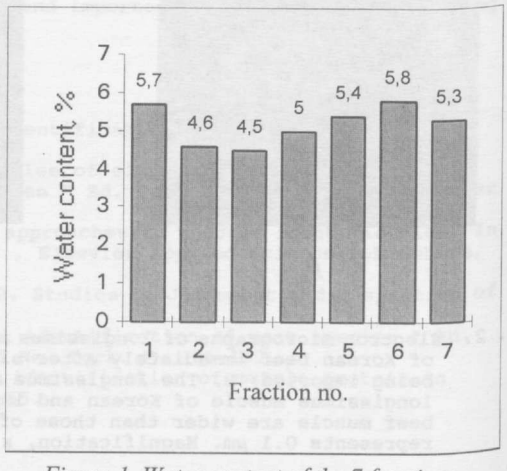

Figure 1. Water content of the 7 fractions.

The protein content of the 7 fractions expressed as protein in percent of dry matter (figure 2) grows with increasing size of particle. The denaturation of proteins leads to

formation of large complexes of cross-bound proteins and during sifting, these protein complexes will be retained while smaller parts such as native proteins and salts will pass th rough the sieves and occur in fractions of smaller particle size. This way fractions consisting of the largest particles would also be the ones containing the highest amount of protein.

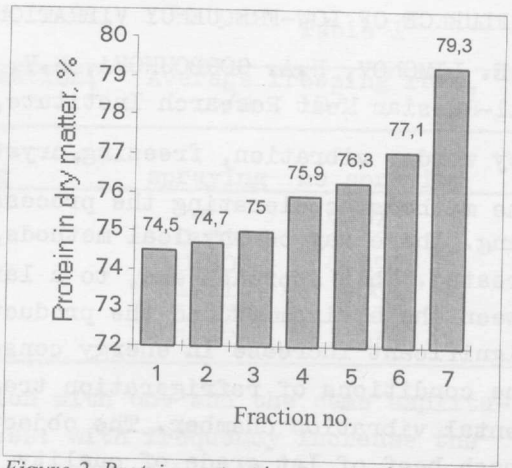

Figure 2. Protein content in percent of dry matter in the 7 fractions.

Results of the color measurements are shown in figure 3 and 4. L* is an expression of the intensity of light reflected from the sample and a* and b* are the chromatographic coordinates. The higher the L*-value the more light is reflected from the sample i.e. the lighter the sample appears. Positive values of a* indicates different intensities of the red color, negative values correspond to the green color. For positive values of b* the color is yellow, for negative values it is blue. In all fractions of the TFM plasma the a*- and b*-values were positive, meaning that red and yellow colors were detected. The yellow color is likely to be derived from a number of colored plasma proteins such as bilirubin and carotenoids, and the red color could have its origin in different forms of hemoglobin.

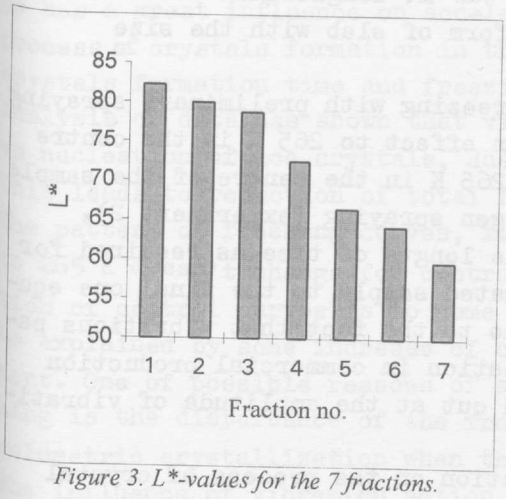

Figure 3. L-values for the 7 fractions.*

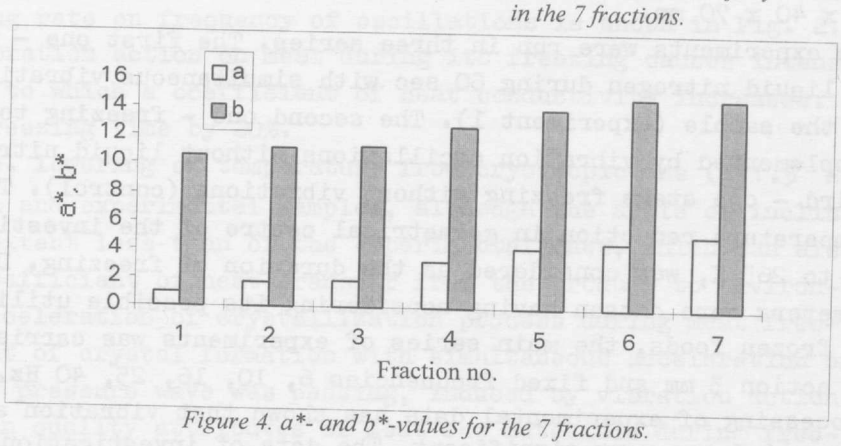

Figure 4. a- and b*-values for the 7 fractions.*

The results show that largest particles appear to be the darkest (low L*-values, figure 3) and have the highest content of yellow and red colors as well. The coarsest particles being the darkest is a common optical phenomenon, but preliminary experiments have shown, that grinding does not reduce the color of the coarse particles to match the fine particles.

Also the solubility indicates that benefit could be obtained by removing the highest numbered fractions (figure 5). With the exception of fraction no. 1 all fractions show decreasing solubility (protein solubility as well as total solubility) with increasing particle number, again suggesting that the largest particles consist of denatured protein.

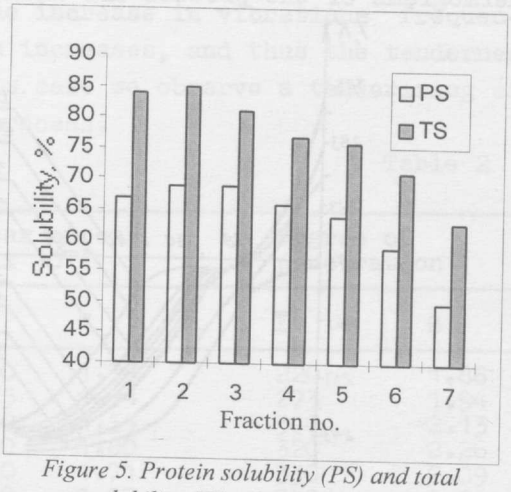

Figure 5. Protein solubility (PS) and total solubility (TS) of the 7 fractions.

To examine whether fractionation of the TFM plasma could improve the overall solubility and color, the 3 smallest fractions, 1-3, were pooled leaving out the coarsest particles (fraction 4-7). The pool of small fractions accounted for 90,4 % of all particles. Comparison of this pool with the initial non-fractionated TFM plasma is given in table 2. By removing the coarser particles a small increase in total solubility has been gained whereas the protein solubility is unchanged. Also a small reduction in the red and yellow colors and an increase in the lightness in the fractionated TFM plasma is seen.

Conclusions

The dark color and low solubility of TFM plasma are closely related to the coarsest particles. The protein solubility and total solubility of the coarsest particles are respectively 34 % and 33 % lower than of the finest particles, and the a*- and b*-values are markedly higher in the coarse particles compared to the fine. Furthermore the lightness, L*, is highest in the fine particles. Particles larger than 0,150 mm make up 9,6 % of the TFM plasma and when removed from the plasma powder, a small but noticeable improvement is made in regard to the L*-, a*- and b*-values and the total solubility.

	L*	a*	b*	PS	TS
Pool of fraction 1-3	76,89	1,77	10,62	67	82
Non-fractionated TFM plasma	79,07	1,84	11,34	67	80

Table 2. Comparison between fractionated and unfractionated TFM plasma.