THE AMINO ACID COMPOSITION OF BOVINE SEMEN*

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Very few data are available concerning the amino acid content of mammalian sperm. The early work by Kossel (1) on the protamines of fish sperm and on the histones was primarily concerned with an attempt to elucidate the structure of the basic proteins. The basic proteins are, in general, characterized by a high arginine content. Zittle and O'Dell (2) have determined the methionine content of whole bovine spermatozoa and found an average value of 1.92 per cent (moisture- and fat-free basis). Since the literature is obviously incomplete with respect to the amino acid content of sperm and since some of the problems of infertility might conceivably be related to one or more of the chemical constituents of semen, it seemed advisable to initiate a study of the amino acid composition of bovine semen.

EXPERIMENTAL

Preparation of Semen for Analysis—The amino acid values reported in this paper represent a composite of 149 semen samples obtained from forty different bulls. These bulls were used routinely for artificial insemination and were of the Holstein, Guernsey, and Jersey breeds. All samples were collected by means of the artificial vagina. As the samples were collected they were preserved by freezing at $-10^\circ$ in a stoppered container until a total volume of 250 ml. was obtained. At this time the composite sample was removed from the freezer, thawed, and centrifuged at 5000 R.P.M. for 30 minutes. The supernatant liquid or seminal plasma was decanted, the cells washed once with water, centrifuged, and the wash liquid discarded. The sperm and seminal plasma were again frozen and then dried in this state by sublimation, and the resulting products were white amorphous powders. The seminal plasma dried in this manner contained 1.4 per cent dry matter, while the sperm contained 20 per cent dry matter. Further drying in vacuo for 48 hours at $60^\circ$ over phosphorus pentoxide showed that the freeze-dried seminal plasma contained 0.76 per cent moisture while the

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sperm contained 6.80 per cent moisture. These dried products were used for the determination of eleven amino acids.

Methods—The amino acid determinations were carried out microbiologically with the organisms *Lactobacillus arabinosus*, *Streptococcus faecalis*, and *Leuconostoc mesenteroides*. The media used in the various determinations are essentially the same as those described by Sauberlich and Baumann (3). The samples were prepared for assay according to the method given by Stokes et al. (4) with the exception of the samples for tryptophan, which were prepared according to the method of Wooley and Sebrell (5). Media for stock cultures as well as the inoculum were prepared according to Kuiken et al. (6). Determinations were made in triplicate and all values were checked to within ±5 per cent. Amino acid determinations were also carried out with a sample of purified casein and these values checked with those in the literature (7).

**Results**

The sperm and seminal plasma contained 17.61 and 12.05 per cent nitrogen respectively (Kjeldahl) when corrected for moisture, fat, and ash. No attempt was made to convert the nitrogen values to percentage of the protein because of the possibility of the presence of non-protein nitrogenous compounds. However, one possible compound, spermine, could not be detected in the semen of the bull (8). Both the dried sperm and seminal plasma are high in protein.

The amino acid composition of sperm and seminal plasma is shown in Table I. The compositions of the two dried materials are quite similar.

### Table I

**Amino Acid Composition of Sperm and Seminal Plasma**

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Sperm</th>
<th>Seminal Plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arginine</td>
<td>25.47</td>
<td>7.91</td>
</tr>
<tr>
<td>Histidine</td>
<td>2.54</td>
<td>2.13</td>
</tr>
<tr>
<td>Lysine</td>
<td>5.08</td>
<td>4.86</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>1.59</td>
<td>2.63</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>3.81</td>
<td>3.42</td>
</tr>
<tr>
<td>Methionine</td>
<td>1.81</td>
<td>1.61</td>
</tr>
<tr>
<td>Threonine</td>
<td>3.78</td>
<td>3.20</td>
</tr>
<tr>
<td>Leucine</td>
<td>5.20</td>
<td>3.81</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>3.42</td>
<td>2.79</td>
</tr>
<tr>
<td>Valine</td>
<td>3.73</td>
<td>3.11</td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>8.33</td>
<td>7.75</td>
</tr>
</tbody>
</table>

*All the values are expressed on the moisture-, ash-, and fat-free basis.*
with the exception of arginine, leucine, and tryptophan. As was expected, the arginine content of sperm was found to be very high, whereas the concentration of this amino acid in seminal plasma was relatively lower, although the proportion exceeded that of any other of the amino acids studied with the possible exception of glutamic acid. Dried seminal plasma contained a higher concentration of tryptophan than sperm. Methionine is relatively low in both sperm and seminal plasma, a characteristic of many animal and plant proteins. The amino acid distribution in the proteins of sperm and seminal plasma is unusual, as is also the case with such specialized proteins as the keratins and hemoglobins (7).

SUMMARY

The concentration of eleven amino acids in bovine sperm and seminal plasma is reported.

With the exception of arginine, leucine, and tryptophan, the amino acid composition of sperm and seminal plasma is quite similar. The arginine content of sperm is very high but is relatively much lower in seminal plasma. The tryptophan concentration in seminal plasma is considerably higher than that found in sperm.

BIBLIOGRAPHY

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