OSMOTIC RELATIONSHIPS IN THE HEN'S EGG AS DETERMINED BY RELATIVE VAPOR PRESSURES

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The present paper contains data obtained by determining relative differences in the vapor pressures of the yolk and white of the hen's egg. These data support previous conclusions that the yolk of the newly laid egg has a greater osmotic pressure than the white.

In a previous paper the writer (1) presented freezing point data which supported the conclusion that the yolk has the greater osmotic pressure. These results are contrary to those of Howard (2) who by the use of the writer's (3) freezing point method found the osmotic pressure of yolk and white to be the same. Howard's variations were due to an altered technique in the use of this method. That this altered technique in the manner of determining the freezing point of a highly viscous substance such as egg yolk gives freezing point values which are too high was shown by the data of the writer's (1) previous paper.

Some of the freezing point determinations have since been repeated and it was found as before that if vigorous stirring, during the freezing point determinations, such as Howard insists upon, is interrupted, the temperature recorded by the thermometer drops immediately and at a faster rate than could be brought about by the abstraction of heat by the cooling bath. This sudden temperature drop can only be due to the fact that the thermometer becomes heated by the stirring (which is carried out by means of the thermometer) and records a temperature which is higher than that of the egg yolk not in immediate contact with it. If upon reaching the type of temperature plateau which Howard (2) describes, the temperature of the cooling bath is rapidly raised above that of the yolk, the thermometer will still record a drop in temperature when vigorous stirring is interrupted.

Vapor pressure data published by Howard (2) also indicate that the osmotic pressures of yolk and white are the same. Baldes (4) has recently reconfirmed the existence of a difference in vapor pressure between yolk and white and has shown that there is a gradient of osmotic pressure in the yolk from low near the surface to high inside.

In the present experiments yolk and white were exposed to the same atmosphere and allowed to progress toward an isosmotic state by the distillation of water from one to the other, with the use of air as the intervening "membrane."

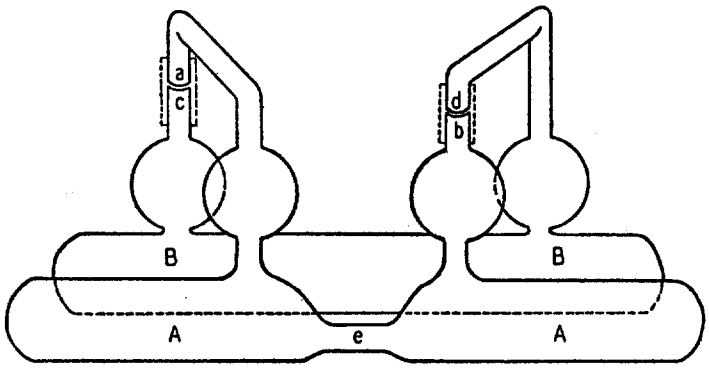

FIG. 1

Experimental Technique

After a series of preliminary experiments with various types of apparatus at various temperatures the following apparatus and technique were adopted. The apparatus consisted of two glass tubes, *A* and *B*, illustrated in Fig. 1. Each of these tubes had a capacity of about 60 ml. Tube *A* was charged with egg white and *B* with yolk. After charging, the tubes were connected at *ac* and *bd* with heavy walled pressure tubing and the joints tightly wrapped with rubber bands. To avoid contact with water they were then mounted and sealed within a 3 liter glass jar which in turn was placed into a 300 liter constant temperature water bath. The temperature of the bath was kept at 50° and fluctuated but a few hundredths of a degree. The constriction in the centre of the tube *A* was such that when the tubes were rocked back and forth, egg white would flow from one compartment of *A* to the other and back again, while the air, with which the yolk and white were in contact, was forced to flow back and forth through the tube *B*. This rocking motion not only kept the liquids in both tubes well stirred but brought the air above them into alternate contact with the liquids in both tubes and thus forced water to distill from the liquid with a lower osmotic pressure to that with a

higher one. Rocking was continued at 50° for about 90 hours in each experiment. The same precautions were used in the preparation of yolk and white as previously described (1).

EXPERIMENTAL RESULTS

The data of Table I were obtained with unfertilized eggs.

In Experiments 1–4 the osmotic concentrations of yolk and white were left in their natural state. In Experiments 5 and 6 sufficient sodium chloride was added to the white to raise its osmotic pressure

TABLE I

No.	Material	Weight of charge	Change in weight
			gm.
1	Yolk	13.319	+0.029
	White	16.360	−0.035
2	Yolk	13.347	+0.030
	White	16.359	−0.040
3	Yolk	12.870	+0.019
	White	16.251	−0.031
4	Yolk	14.632	+0.034
	White	17.985	−0.042
5	Yolk	13.190	−0.038
	White + 0.4 gm. NaCl per 100 cc.	19.396	+0.028
6	Yolk	13.318	−0.030
	White + 0.4 gm. NaCl per 100 cc.	18.905	+0.020
7	Yolk	13.409	+0.023
	White + 0.12 gm. NaCl per 100 cc.	17.911	−0.028
8	Yolk	13.475	+0.014
	White + 0.12 gm. NaCl per 100 cc.	21.066	−0.026

above that of the yolk by as much as that of the yolk is naturally above that of the white. In Experiments 1–4 water distilled from white to yolk while in Experiments 5–6 water distilled from yolk to white. In Experiments 7–8 sufficient salt was added to the white to lower its freezing point by one-half the difference naturally existing between yolk and white. In this case, too, water distilled from white to yolk.[1]

[1] That the loss in weight of water on one side is greater than the gain on the other is evidently due to the loss of water from the tubes because of the pressure developed when they were brought to the temperature of the bath. A negative pressure was always found to exist within the tubes when, after an experiment, they were brought back to room temperature.

Freezing point determinations were made before and after heating yolk and white to 50° for 90 hours and were found not to have been appreciably altered by this period of incubation.

DISCUSSION

While these data, because of the nature of these experiments, do not give the exact osmotic pressures of egg yolk and egg white, they do show definitely that the osmotic pressure of egg yolk is greater. No other explanation can be given for the fact that water continued to distill from white to yolk when a considerable amount of salt had been added to the white. It would appear, therefore, that Howard's recent claim (5) that freezing point data previously reported were "erroneously" obtained is unjustified, and that Howard's modification of the writer's freezing point method requires further consideration before it can be accepted.

CONCLUSION

It has been shown by a comparison of the relative vapor pressures of egg yolk and egg white before and after the addition of sodium chloride to the white that the osmotic pressure of the yolk is greater than that of the white.

BIBLIOGRAPHY

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An additional bibliography of previous work will be found in the papers cited above.