CHAPTER III

EXPERIMENT

3.1 Apparatus

3.1.1 Dryer

A tray drier was built in this work to dry gelatin sol. Its diagram is shown in Figures 3.1a and 3.1b. Its main components are as follows.

(a) Electrical blower: $\frac{1}{4}$ H.P., 3,000 RPM

(b) Heater: heating chamber containing four heating elements of 1,200 watt each.

(c) Balance: total capacity of 280 gm and probable accuracy of $\pm$ 0.05 gm, manufactured by Marumo.

(d) Temperature controller: temperature range of thermostat is 50 ^{o}F to 250 ^{o}F and $\pm$ 5 ^{o}F differential

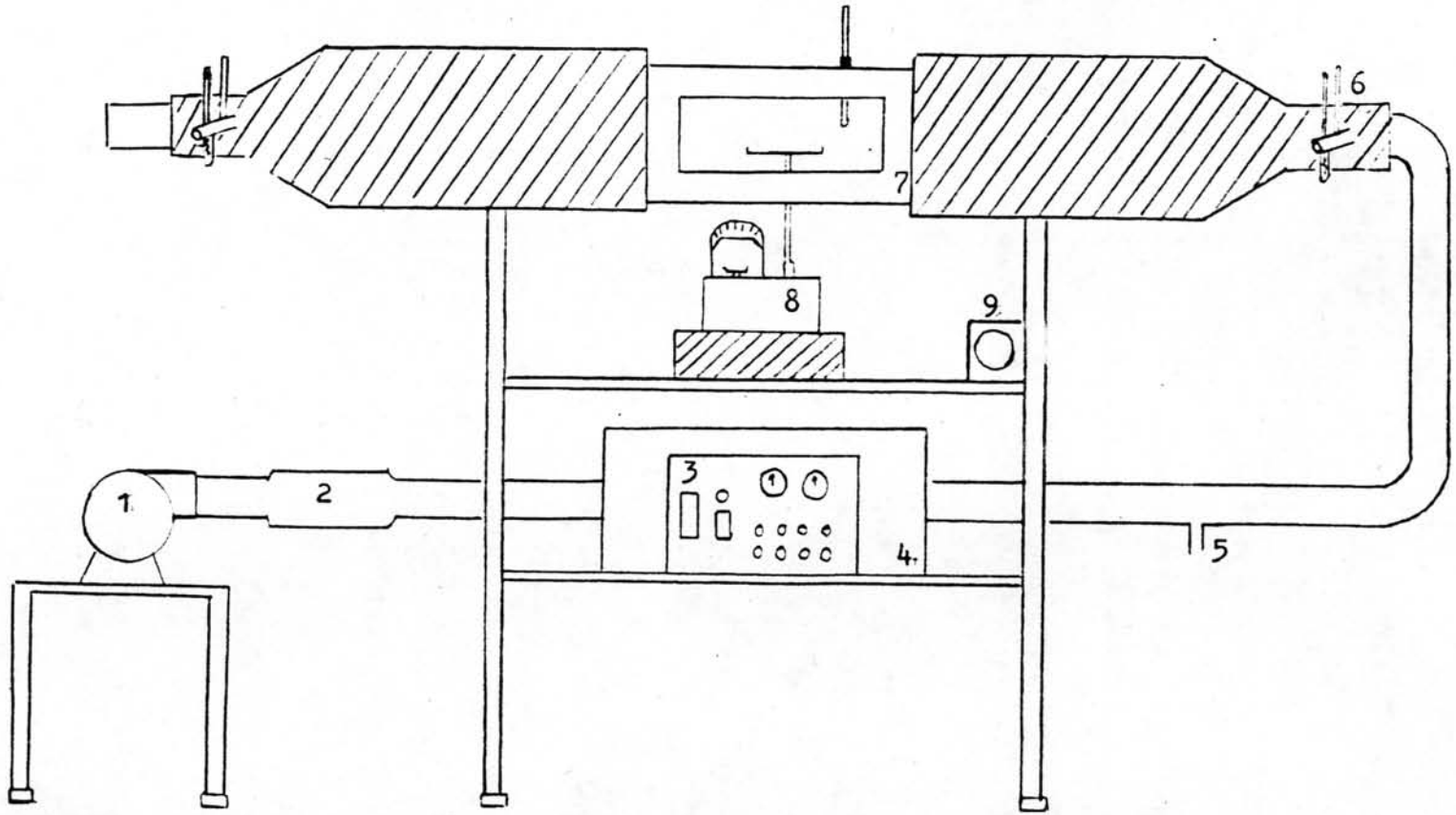
(e) Anemometer

(f) Wet bulb dry bulb thermometers

3.1.2 Apparatus for Determination of Gelatin Properties

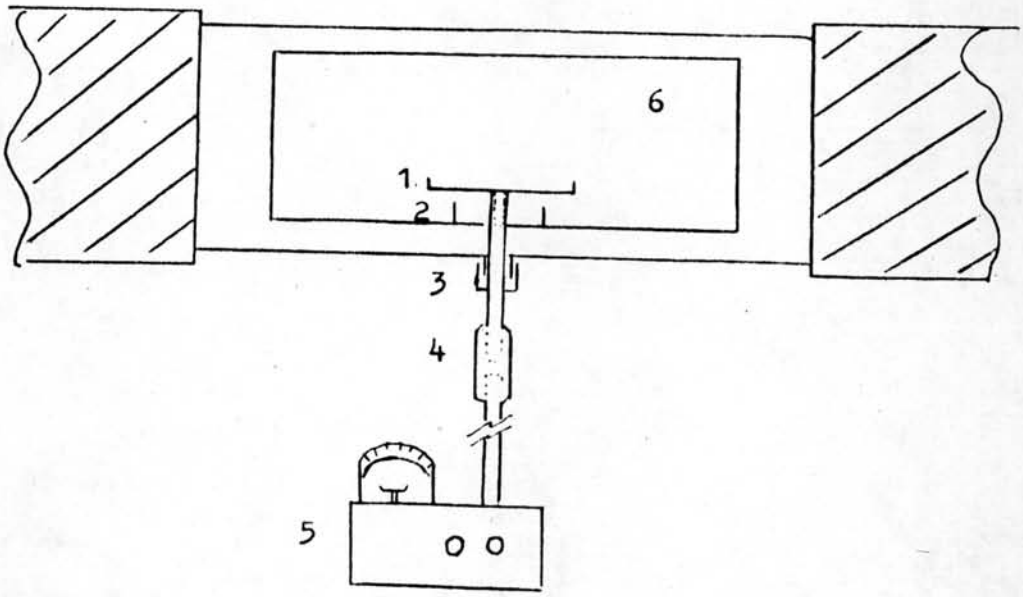
3.1.2.1 Apparatus for Determination of Bloom Strength

(a) Bloom Type gelometer: Boucher Electronic Jelly Tester was used. Its photograph is shown in Figure 3.2. The instrument operates on the torsion wire principle. When the surface of the sample lifts the plunger fractionally it causes a red switch to operate. This stops to table motor and starts a motor which turns the torsion wire to which



1. Blower
2. Air filter
3. Switch panel board
4. Heater
5. Water vapor inlet
6. Wet bulb, dry bulb thermometer
7. Drying chamber
8. Balance
9. Thermostat

Figure 3.1a Arrangement of apparatus



1. Pan
2. Pan seat
3. Oil seal
4. Plastic insulating joint
5. Balance
6. Drying chamber

Figure 3.1b Diagram of the drying chamber and the balance.

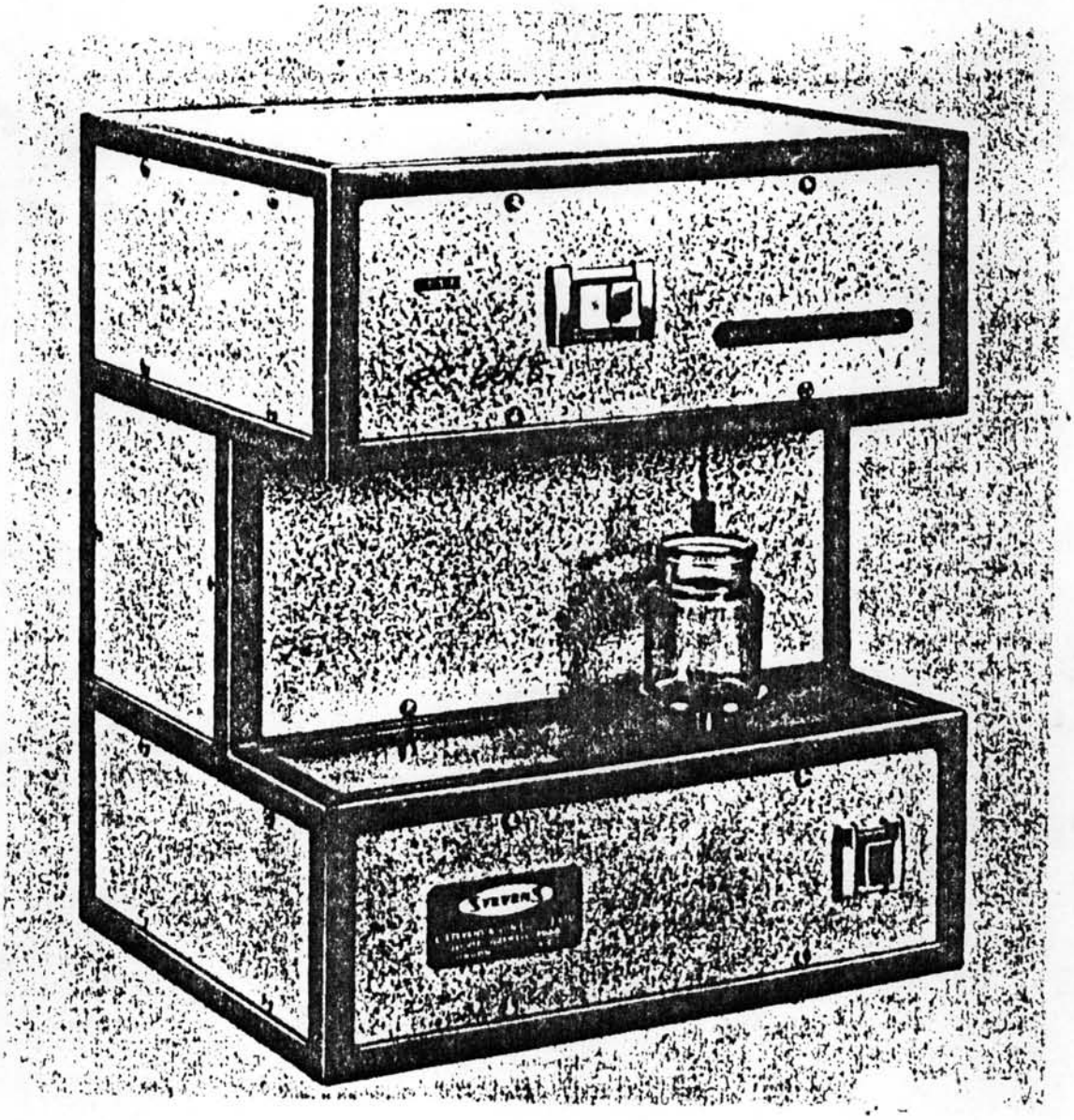


Figure 3.2 Bloom Gelometer (Boucher Electronic Jelly Tester).

Cannon-Fenske No. 100 F 205 was used for determination of viscosity of gelatin solution.

3.2 Experimental Procedure

3.2.1 Drying

(a) Preparation of Samples

- Preparation of Gelatin Sol

The gelatin powder was weighed in a beaker and the distilled water was added in the ratio 1:4. The mixture was stirred with a glass rod and allowed to soak for 3 hours. Then the beaker was placed in a hot water bath for about 30 minutes. The final temperature of the gelatin solution in the bath was 50 ^{o}C. The solution was set for about 30 minutes to eliminate foam.

- Preparation of Gelatin Gel

Gelatin sol was placed in a rectangular of 0.0317 m^2 surface area and 2.2 mm depth. It was left until its temperature approached room temperature, and then it was placed in a refrigerator to form gel at about 10 ^{o}C.

(b) Data Recording

When controllable parameters, i.e., flow rate of air, wet bulb and dry bulb temperature, has been checked to be steady,

the experiment began. Gelatin sol was placed in the dryer, and the following data were recorded at various time intervals: balance readings of tray weights, wet bulb and dry bulb temperatures.

The air flow rate was set by adjusting the inlet opening of the blower. Humidity was set by adding steam of control rate to the hot air.

Before drying rate experiment, the balance reading was calibrated at various air flow rates and temperature with known weights. It was found that the air flow rate and air temperature had no effect on the balance reading. Consequently, in later experiment weights of drying samples was read directly from the balance scale.

3.2.2 Method for Determination of the Gelatin Properties

3.2.2.1 Method for Determination of the Bloom Strength

According to the British standard method, the Bloom strength is the measured weight in gram necessary to produce, by means of a plunger of 12.7 mm diameter a 4 mm depression in a gel of $6\frac{2}{3}$ percent concentration by weight matured at 10 ^{o}C.

the beam and the plunger assembly is attached. As the number of half turns made by the torsion wire motor and registers on the digital counter. The torsion wire never turns more than 180 ^{o} as a safety cut-out operates to stop the torsion wire motor, preventing overstrain and giving a long life. The distance of movement of the plunger is limited by a further red switch at the end of the beam.

Before testing the samples, the Bloom gelometer was checked with a Dummy Bloom[1] for correct adjustment and operation. A Dummy Bloom consists of a stand and four calibrated spring steel strips approximating to Bloom values of 80, 100, 200 and 300 gm. These steel strips simulate tests with gels and thus provide a reliable and convenient method of checking a gelometer.

(b) Bottles: of internal diameter 59$\pm$1 mm and 8.5 mm in height, having a capacity of approximately 155 ml. A stopper of rubber approximately 43 mm in diameter fitted snugly into the neck of the bottle, it was pierced contrally with air vent about 0.5 mm in diameter.

(c) Thermostatic bath: the Stevens Chill Bath which has been designed specially for the preparation of gelatin was used. It had special rack to hold 20 gelatin sample bottles as shown in Figure 3.3. Each bottle was located in a circular hole 67 mm diameter in a stainless steel top shelf and stood on a solid perspex lower shelf strengthened to prevent bowing. When the sample bottles were in position ensuring that the gel set evenly in sample bottle. The cooler unit enabled the bath to be operated at 10 ^{o}C $\pm$ 0.05 ^{o}C in room temperature up to 25 ^{o}C.

3.2.2.2 Viscosmeter

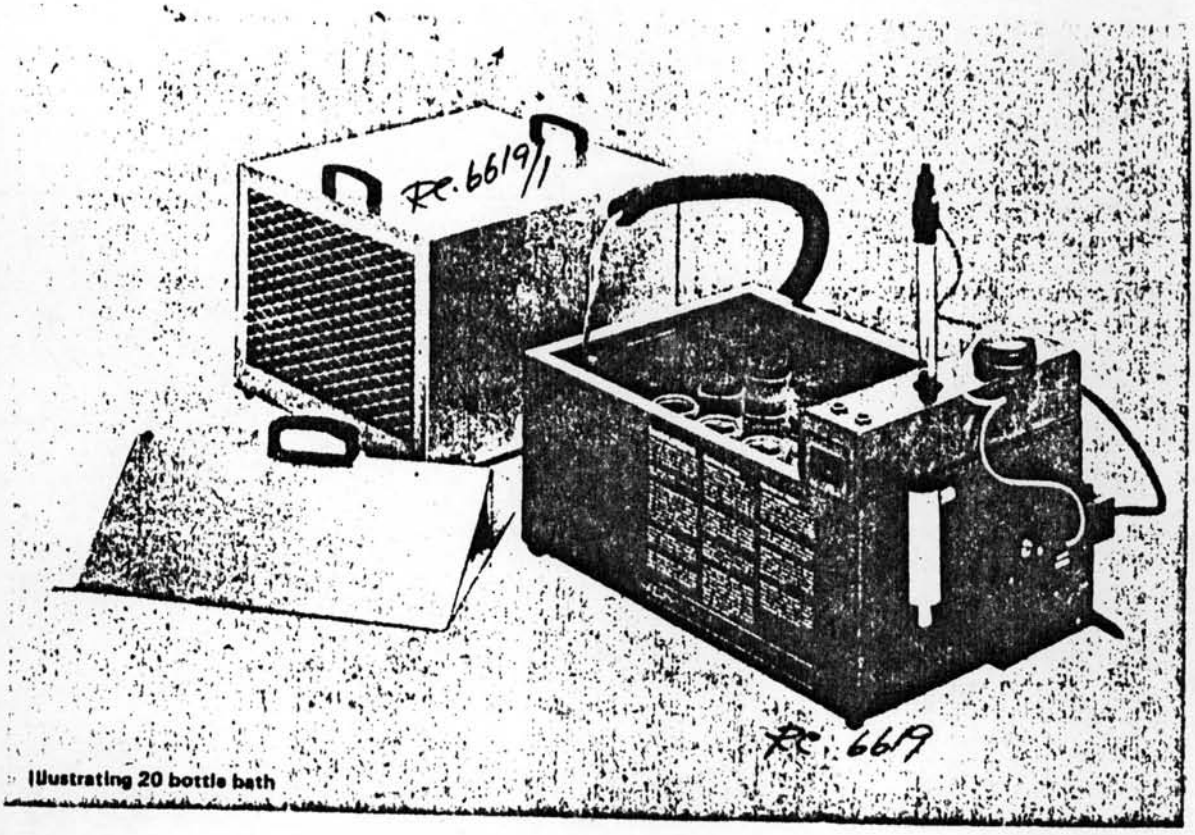


Figure 3.3 Thermostatic Bath (Steven Chill Bath).

(a) Dissolving the sample

7.5 gm of the powdered sample was placed in a Bloom bottle and well mixed with 105 ml of distilled water. The Bloom bottle was closed with the stopper. This mixture was allowed to soak for 3 hrs. When the gelatin was completely swollen, the Bloom bottles was then heated in a water bath for about 15 minutes, taking care that the final temperature of the solution, when in the bath reached but not exceed 60 ^{o}C. This was secured by adjustment of the bath temperature, which must on no account exceed 70 ^{o}C. During this heating period, there was gentle stirring with a rod, to minimize evaporation loss. Care was taken that the gelatin was completely dissoved: this was ascertained by lifting up the Bloom bottle and looking through the bottom. The finger was placed over the perforation in the stopper to invest the Bloom bottle several times to mix in the water had condensed on the walls of the bottle and underside of the stopper and care was taken to avoid producing a layer of foam on the gelatin solution. Any samples gelled with foam in the centre of the surface, where the gelometer plunger was placed was rejected. When the sample had all dissolved, the Bloom bottle was removed from the water bath.

(b) Chilling the solution

To prevent cracking, the Bloom bottle was allowed to cool for 15 minutes at room temperature, and then placed in the thermostatic bath for not less than 16 hours and not more than 18 hours. Care was taken so that bottle stood evenly on it. The bath temperature was maintained at 10$^{\pm}$ 0.1 ^{o}C. After temperature equilibrium was complete at 10 ^{o}C rigidity still increased but at a declining rate, so that after 16 hours at 10 ^{o}C the rigidity of a good quality gelatin was increasing

by only about 0.5 percent. Therefore the specification of 16-18 hours maturing at 10 ^{o}C is satisfactory for routine gel strength determination purposes.

(c) Measurment of Bloom Strength

Bloom strength determinations was made after the gelometer had been checked and adjusted. The only precaution necessary during the measurements was to ensure that the gelometer plunger made contact with the gel surface at the approximate centre. After the completion of each test, the gel surface was examined for cracking and splitting, and test result rejected where this had occurred.

(d) Factors affecting Bloom strength Determinations

Moisture content of samples is an important factor affecting Bloom strength determinations. When Bloom strengths are reported, the results of moisture content of a sample, at the time of determining its Bloom strength is obvious.

An approximate formula[3], for calculating the effect of moisture content change on Bloom strength is

$$\Delta B = \frac{-2B_1 \Delta M}{100-M_1} \qquad \ldots\ldots(3.1)$$

When B_1 is the Bloom strength at percent moisture content M_1 and ΔM is the difference between agreed moisture content and M_1

3.2.2.2 Method for Determination of Viscosity

(a) Procedure

7.5 gm of the powdered sample was placed in a flask and 105 ml of cold distilled water was added. The sample was swelled and dissolved

in the manner specified in Bloom strength determination. Then, the liquid was poured through a funnel, loosely plugged with cotton wool into the viscometer bulb until meniscus was above the top mark of the bulb. The time for meniscus to drop from the top mark to the bottom mark, underneath the bulb was timed with a stopwatch. Duplicate measurements did not vary by more than 0.3 seconds.

(b) Factor affecting Viscosity Determinations

- Timing Errors

Kragh[4] indicates that a careful operator should be able to measure Ostwald viscometer flow times to within $\pm$ 0.05 sec. This is well within the accuracy required for normal commercial tests.

- Concentration Requirements

The viscosity of gelatin solution are determined at standard concentration of $6\frac{2}{3}$ percent gelatin solution. Kragh and Langston[5] report that an approximate formula for calculating the change of gelatin viscosity with moisture content is

$$\Delta\eta = \frac{-2\eta_1 \Delta M}{100} \qquad \ldots\ldots(3.2)$$

Where η_1 is the viscosity at a given moisture content. Therefore, it is essential to measure and quote the moisture content of a gelatin sample at the time that its viscosity is determined.

3.2.2.3 Method for Determination of Moisture content

Using an analytical balance, approximately 5 gm of gelatin was weighed into an aluminium dish with cover (AOAC type, 55 mm inside diameter at top by 15 mm depth). The gelatin was heated in an air oven at 105 ^{o}C $\pm$ 1^{o}C for 17 hours $\pm$ 1 hour with the lid partially removed.

The cover was replaced and cooled in a dessicator using an efficient dessicant. Loss in weight as percent moisture could be determined.

3.3 Experimental Scheme

The experimental scheme is presented in Table 3.1 to 3.3

Table 3.1 Varying air flow rate

Run No.	Thickness of sol (mm)	Drying Temp. $^{o}C \pm 3.0\ ^{o}C$	Air Flow rate (m/sec)
1	2.2	76.0	2.16
2	2.2	76.0	3.86
3	2.2	76.0	4.39
4	2.2	98.0	2.72
5	2.2	98.0	3.37
6	2.2	98.0	3.84
7	2.2	98.0	4.39

Table 3.2 Varying Thickness and air Temperature

Run No.	Thickness of sol (mm)	Drying Temp. ($^{o}C \pm 3.0^{o}C$)	Air Flow rate (m/sec)
12	1.5	30.0	4.39
8	2.2	30.0	4.39
13	3.5	30.0	4.39
14	4.5	30.0	4.39
15	1.5	57.0	4.39
9	2.2	57.0	4.39
16	3.5	57.0	4.39
17	4.5	57.0	4.39
18	1.5	76.0	4.39
3	2.2	76.0	4.39
19	3.5	76.0	4.39
20	4.5	76.0	4.39
21	1.5	98.0	4.39
11	2.2	98.0	4.39
22	3.5	98.0	4.39
23	4.5	98.0	4.39

Table 3.3 Varying humidity

Run No.	Thickness of sol (mm)	Drying Temp. ($^{o}C \pm 3.0\ ^{o}C$)	Air Flow rate (m/sec)	% Relative Humidity
11	2.2	98.0	4.39	5
10	2.2	98.0	4.39	8.5
27	2.2	98.0	4.39	13
28	2.2	98.0	4.39	23