1 GELATIN

1.1 Introduction

India ranks topmost in the world in livestock holding and has the potential to utilize slaughterhouse by products to partly meet the growing requirement of animal feeds. The total availability of offal/bones in the country generated from large slaughterhouses is estimated to be more than 21-lakh tonnes/annum.

Gelatin is defined as a "product obtained from partial hydrolysis of collagen derived from natural sources such as skin, connective tissue, and bones of animals." It is an easily digestible protein that contains all the essential amino acids except tryptophan. Gelatin is NOT a chemical or chemically modified substance.

Gelatin is typically produced in a powdered or granulated form. Slightly yellow to light tan in color, it is a rather tasteless and odorless substance.

Gelatin, a typical protein, acts both as an acid and as a base. Thus, it is an amphoteric substance and can be titrated with acids and with alkalies. There are relatively few ionizable groups in gelatin and these are the ones which can be titrated. They are contributed by the carboxyl groups of aspartic and glutamic acids, the imidazolium of histidine and the guanidinium of arginine. In addition, there are terminal amino and carboxyl groups.

Commercial gelatin is nearly tasteless and odourless, a brittle, vitreous solid, very faint yellow to amber in colour. At normal temperature and humidity, it contains 9-12% moisture. Its specific gravity is about 1.3-1.4. It dissolves in warm water to form solutions having a faint, bouillon like aroma. The important properties of a gelatin solution are functions of pH, electrolytic impurities, methods of preparation from collagen, thermal history, aging and concentration. Gelatin is extremely heterogeneous, being composed of polypeptides of many sizes and it must never be regarded or treated as a single chemical entity. It is classified as a derived protein because it is obtained from collagen by hydrolytic action.

Gelatin molecules, like those of other proteins, are large and complex. Values for the average molecular weight range from 15,000 to 250,000. Gelatin is composed of about 18 different amino acid radicals which are linked together in an ordered fashion. These amino acids obtained by the complete hydrolysis of gelatin, are listed in table below. Gelatin analyses in terms of the elements 50.5% carbon; 6.8% hydrogen; 17% nitrogen and 25.2% oxygen.

Amino Acids Obtained by Complete Hydrolysis of Gelatin

Amino acid	% by wt.
Alanine	**11.0**
Arginine	**8.8**
Aspartic acid	**6.7**
Glutamic acid	**11.4**
Glycine	**27.5**
Histidine	**0.78**
Hydroxproline	**14.1**
Leucine & isoleucine	**5.1**
Lysine	**4.5**
Methionine	**0.9**
Phenylalanine	**2.2**
Proline	**16.4**
Serine	**4.2**
Threonine	**2.2**
Tyrosine	**0.3**
Valine	**2.6**
Crystine	**trace**

Commercial gelatins vary from 50 to 300 Bloom grams and, except for specialty items, are free of added colors, flavors, preservatives, and chemical additives. Gelatin is a generally recognized as safe (GRAS) food ingredient.

Typical specifications for edible gelatins are:

	Type A	Type B
pH	3.8 - 5.5	5.0 - 7.5
Isoelectric Point	7.0 - 9.0	4.7 -5.4
Gel Strength (Bloom)	50 - 300	50 - 300
Viscosity (mps)	15 - 75	20 - 75
Ash	0.3 - 2.0	0.5 - 2.0

Two of gelatin's most desirable properties are its melt-in-the-mouth characteristics and its ability to form thermoreversible gels. In addition, gelatin is relatively unaffected by ionic strength and is stable over a broad pH range. Gelatin is preferred in many applications for its clarity and bland flavor.

The Table below lists several food categories which utilize gelatin, and recommended use levels and Blooms.

Table 1 Gelatin as a food ingredient

	Use Level	Gelatin Bloom
Dairy Products	.2 - 1.0%	150 -250
Frozen Foods	.1 - 0.5%	225 - 250
Gelatin Desserts	7 - 9%	175 - 275
Confectionery		
Gummi Bears	7 - 9%	200 - 275
Marshmallows	1.7 - 2.5%	225 - 275
Circus Peanuts	2.0 - 2.5%	225 - 250
Lozenges	.5 - 1.0%	50 - 100
Wafers	.5 - 1.0%	50 - 100
Bakery Fillings & Icings	1.0 - 2.0%	225 - 250
Meat Products	1.0 - 5%	175 - 275
Wine, Beer, Juices	.002 - .015%	100 - 200

Gelatin is compatible with a wide variety of foods and ingredients. In fact, it has been used to help keep together ingredients that are incompatible. Some general nutritional information on gelatin is presented in table below.

Table 2 Gelatin nutritional information

	Type A	Type B
Moisture (%)	10.5 +/- 1.5	10.5 +/- 1.5
Fat (%)	0	0
Carbohydrates (%)	0	0
Ash (%)	.5 +/- .4	1.5 +/- .5
Sodium (ppm)	500 +/- 200	3600 +/- 1400
Phosphorous (ppm)	1 +/=.8	---
Iron (ppm)	4 +/- 2	15 +/- 10
Lead (ppm)	.002 +/- .002	.005 +/- .002
Zinc (ppm)	1.5 +/- .5	5 +/- 3
Nitrogen (%)	16.2 +/- .3	16.2 +/- .3
Calcium (ppm)	90 +/- 30	900 +/- 100
Potassium (ppm)	125 +/- 50	330 +/- 50
Calories / 100 grams	360	360

1.2 Objective

The primary objective of the model report is to facilitate the entrepreneurs in understanding the importance of setting up unit of gelatin manufacturing. This model report will serve as guidance to the entrepreneurs on starting up such a new project and basic technical knowledge for setting up such a facility.

1.3 Raw Material Availability

Cattle bone, Hydrochloric acid, Lime, Solvent are the main raw material required for the manufacturing of gelatin. If kept in its original container at ambient humidity and a controlled temperature, gelatin can last practically forever. Most manufacturers like to limit the shelf life to just two or three years; this has more to do with degradation of the packaging than the deterioration of the gelatin.

1.4 Market Opportunities

Surprisingly, gelatin is used in a variety of consumer products. Without identifying the application rationale, a short list of products in which gelatin is present include:

- Dairy – ice cream, sour cream, yogurt, cottage cheese, cream pies
- Meat – ham, aspics, canned hams, meat loaves, pates
- Desserts – jellied desserts, puddings, frostings
- Confectionery – gum drops, lozenges, wafers, candy cigarettes, marshmallows, fruit snacks, gummi snacks
- Other – consommé soups, sauces

1.5 Project description

Applications

Gelatin has traditionally been used in three major areas: food, pharmaceutical, and photographic industries.

Gelatin use in the food industry is probably best recognized in gelatin desserts and confectionery applications. It is also used as a binding and/or glazing agent in meats.

In the pharmaceutical health industry, gelatin is used to make the shells of hard and soft capsules for medicines, dietary/health supplements, syrups, etc. It is highly digestible and serves as a natural protective coating for medications.

The unique chemical and physical properties of gelatin make it an important component in the photographic industry. Gelatin serves many useful purposes in the preparation of silver halide emulsions in the production of photographic film.

A new, major application for gelatin is in the paintball industry. The classic-style "war games" are played out using projectiles constructed of gelatin.

Gelatin is used in jellies, bakery products, ice creams.

Capacity of the Project

The total installed capacity of the unit is 1160 MT of gelatin per year.

Manufacturing process

The manufacture of gelatin has evolved from the simple digestion of animal bones in a steam heated pressure cooker to a well controlled technical process developed in the early 1920s. As variety of products with desirable properties is available and special processing is required in each case. The steps in manufacture involve isolation and refinement of the insoluble soluble gelatin. The gelatin is further processed by chemical adjustment, filtration for clarification and drying to yield a product of some predetermined quality. Final specifications are usually arrived at by the calculated blending of unit batches; these have been analyzed in the laboratory for physical and chemical properties characteristics of gelatin for highly specified uses in food and technical applications.

Inspection and cutting

When the animal parts arrive at the food processing plant, they are inspected for quality. Rotted parts are discarded. Then, the bones, tissues, and skins are loaded into chopping machines that cut the parts into small pieces of about Sin (12.7cm) in diameter.

Degreasing and roasting

The animal parts are passed under high-pressure water sprays to wash away debris. They are then degreased by soaking them in hot water to reduce the fat content to about 2%. A conveyer belt moves the degreased bones and skins to an industrial dryer where they are roasted for approximately 30 minutes at about 200° F (100° C).

Acid and alkaline treatment

The animal parts are soaked in vats of lime or some other type of acid or akali for approximately five days. This process removes most of the minerals and bacteria and facilitates the release of collagen. The acid wash is typically a 4% hydrochloric acid with a pH of less than 1.5. The alkaline wash is a potassium or sodium carbonate with a pH above 7.

Boiling

The pieces of bone, tissue, and skin are loaded into large aluminum extractors and boiled in distilled water. A tube running from the extractor allows workers to draw off the liquid that now contains gelatin. The liquid is sterilized by flash-heating it to about 375° F (140° C) for approximately four seconds.

Evaporating and grinding

From the extractor, the liquid is piped through filters to separate out bits of bone, tissue or skin that are still attached. From the filters, the liquid is piped into evaporators, machines that separate the liquid from the solid gelatin. The liquid is piped out and discarded. The gelatin is passed through machines that press it into sheets. Depending on its final application, the gelatin sheets are passed through a grinder that reduces them to a fine powder.

Flavoring and coloring

If the gelatin is to be used by the food industry, sweeteners, flavorings, and colorings may be added at this point. Pre-set amounts of these additives are thoroughly mixed into the powdered gelatin.

Packaging

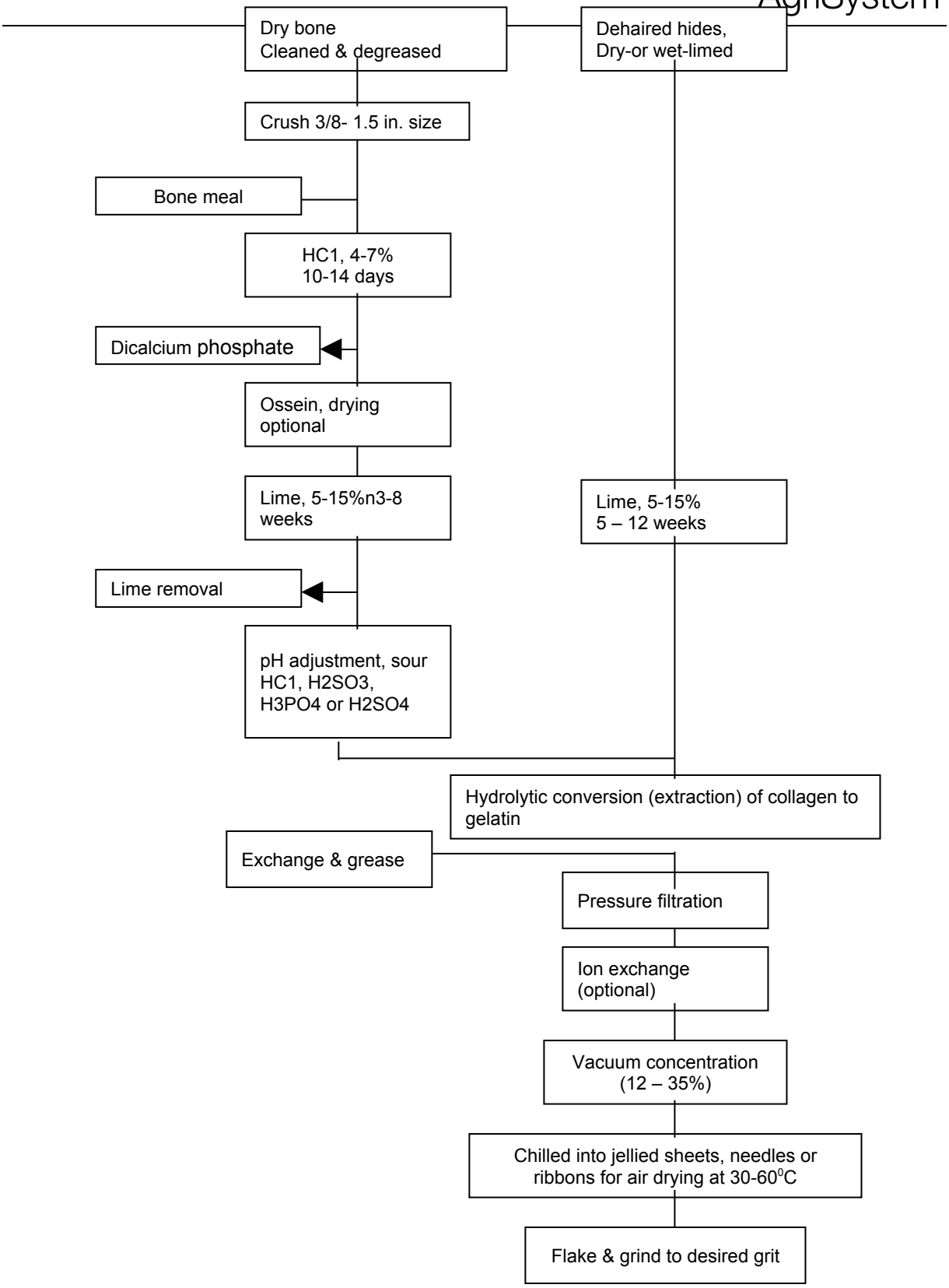
The packaging process is automated, with preset amounts of gelatin poured into overhead funnels through which the gelatin flows down into bags made of either polypropylene or multi-ply paper. The bags are then vacuumed sealed.

1.6 Plant and machineries

- Dry bone crusher
- Rotary extractor with longitudinal steam coils
- Solvent storage tank MS construction
- Vapour condenser and water evaporator
- Other storage tanks
- Solvent recovery plant
- Hammer mill
- Lime dissolver with stirrer CS
- Storage tanks for HCI
- Acidulating tanks rubber lined
- Washing tanks rubber lined
- Cooking tanks CS outlet shell SS 316
- Storage tank light liquor, SS 316
- Pressure filter
- Clear liquid storage tanks SS 316
- Triple effect evaporators with vacuum pump & condenser. All stainless construction.
- Concentrated liquor storage tanks SS 316
- Refrigerated chamber temp. 40C
- Grinder – for finished gelatin
- Air heater-with blower heater boxes maximum 1400C

- Exhaust
- Dryer
- Bone dryer
- Cage mill
- Boiler
- Calcium
- Material handling system
- Other misc. equipment like bins, racks trolleys tools, weighing machines etc.
- Pipe line systems water, steam acid naphtha, air etc.
- Pumps, compressor oil storage tanks etc.
- Demineralizer plant

Flow diagram for Gelatin manufacture



1.7 Project component and cost

Major components of the projects and their costs are described in the table hereunder:

1.8 Land and Building

Particulars	Unit	Qty	Cost/unit	Total
LAND & BUILDING				**467.50**
Land	SqM	11,000	250.00	27.50
Land Development				
Land Area		11,000	500.00	55.00
Building				
Production Block				
Buildup Area	SqM	7,000	5,000.00	350.00
Contingencies		10%		35.00
PLANT & MACHINERY				**120.00**
Plant and machinery	LS	1	10,000,000.00	100.00
Contingencies		20%		20.00
MISCELLANEOUS FIXED ASSETS				**30.00**
Misc. Assets	LS	1	2,500,000	25.00
Contingencies		20%		5.00
PRE-OPERATIVE EXPENSES				**34.39**
Establishment		1	1,420,000	14.20
Preoperative Interest		1	1,659,300	16.59
Security Deposits		1	360,000	3.60
TOTAL				**651.89**

1.9 Plant and Machinery

The total cost of the plant and machinery is Rs. 120 Lakhs.

1.10 Building

The main production block will cost around Rs. 385 lakhs.

1.11 Miscellaneous Assets

A provision of Rs. 30 lakhs would take care of all the requirements.

1.12 Preliminary & Pre-operative Expenses

A provision of Rs. 34.39 lakhs would take care of pre-production expenses like establishment, professional charges, security deposits etc.

1.13 Working capital assessment

ITEMS	Year 1	Year 3	Year 5
STOCK OF RAW MATERIAL & PACKING MATERIAL	9.37	15.62	15.62

SUNDRY DEBTORS		37.96	63.27	63.27
TOTAL		**47.33**	**78.89**	**78.89**
MARGIN		11.83	19.72	19.72
MPBF		35.50	59.17	59.17
INTEREST ON WC		3.91	6.51	6.51

1.14 Means of finance

EQUITY CAPITAL			42.47%	**281.86**
MOFPI SUBSIDY	25%	50.00	7.53%	**50.00**
TERM LOAN				
FINANANCIAL INSTITUTIONS		10.00%	50.00%	**331.86**
-Payable half yearly Installments	10	33.20		
TOTAL			100%	**663.73**

1.15 Cash flow statement

PARTICULARS	Year 1	Year 3	Year 5	Year 7
SOURCES OF FUNDS				
EQUITY CAPITAL	-	-	-	-
SUBSIDY				
NET PROFIT	53.35	135.83	130.57	124.73
(INTEREST ADDED BACK)				
DEPRECIATION	28.73	28.73	28.73	28.73
PRELIMINARY EXP.W/O	4.91	4.91	4.91	4.91
INCREASE IN TERM LOAN	-	-	-	-
INCREASE IN BANK BORROWINGS-WC	35.50	11.83	-	-
TOTAL	**122.49**	**181.30**	**164.21**	**158.37**

1.16 Projected balance sheet

PARTICULARS	Year 1	Year 3	Year 5	Year 7
LIABILITIES				
EQUITY CAPITAL	281.86	281.86	281.86	281.86
RESERVES & SURPLUS	66.25	232.56	459.25	695.99
TERM LOAN	298.66	165.86	33.06	(0.00)
BANK BORROWINGS-WC	**35.50**	**59.17**	**59.17**	59.17
TOTAL	**682.28**	**739.45**	**833.34**	**1,037.02**

1.17 Projected profit and loss account

Particulars	Year 1	Year 3	Year 5	Year 7
INCOME	417.60	696.00	696.00	696.00
EXPENDITURE	330.61	526.53	531.79	537.63
VARIABLE	250.12	409.37	409.37	411.39
FIXED	80.49	117.16	122.42	126.24
GROSS PROFIT	86.99	169.47	164.21	158.37
PROFIT BEFORE TAX	16.25	107.75	115.77	118.22
RETAINED PROFIT	16.25	107.75	115.77	118.22

1.18 Key indicators

NET PRESENT VALUE at current Inflation (Rs. in lakhs)	**742.33**
INTERNAL RATE OF RETURN %	**20.19**
AVERAGE DSCR	**2.10**
BREAK EVEN POINT %	**58.46**
PAY BACK PERIOD (YEARS)	**5.24**

1.19 Manpower Requirement

PARTICULARS		NO.
SUPERVISORY STAFF		
	PRODUCTION SUPERVISORS	1
	ACCOUNTANT	1
WORKERS		
	SKILLED WORKERS	2
	SEMI-SKILLED LABOUR	6
	SALESMAN	1

1.20 Assumptions

Project & Financing			
Contingencies on Building			10%
Contingencies on Equipment			20%
Term Loan			50%
Rate of Interest on Term Loan			10%
Subsidy Considered	Subject to ceiling		25%
Expected time of Installation		Months	3
Moratorium		Months	6
CAPACITY			
Rated Capacity Per Annum	80% of Installed capacity	TPA	253.44
Number of Operational Days	DAYS		330
Working Hours Per day	Hrs		16
CAPACITY UTILIZATION			
Year I			70%
Year II			80%
Year III			90%
SALES PRICE			
W S Price			60000
OTHER EXPENSE			
Commission			10.0%
Marketing Expenses			2.5%
POWER			
Connected Load	HP		40
DEPRICIATION AS PER COMPANY'S ACT			
BUILDING			3.34%
PLANT & MACHINERY			10.34%
MISC. FIXED ASSETS			7.07%
LAND & SITE DEVELOPMENT			1.63%
MAINTENANCE			
BUILDING			1.00%
PLANT & MACHINERY			3.00%
MISC. FIXED ASSETS			2.00%
LAND & SITE DEVELOPMENT			1.00%

Sources of technology

The technology is required to be imported.

The actual cost of projects may deviate on change of any of the assumptions.