**Cost aspects of various stages in the processes development including effluent treatment**

**The various stages in the fermentation and product development processes are-**

1. Medium constitute
2. Fermentation incubation period
3. Contamination and sterilization
4. Yield and product recovery
5. Product purity
6. Labour cost
7. Waste disposal and effluent treatment
8. Research cost
9. **Medium constitute**

* Usually, the costs of different constituents of the production medium decides the competitive position and potential profits of a fermentation product
* For example, inoculum media are usually less expensive because they are designed to promote fast growth of the producer instead of converting a large amount of carbon substrate in the product. At the same time they are require in less volume
* In contrast, production media which are aimed to produce the product required in more volume and may time high-cost of a single medium can affect the selling price the fermentation product
* As any component of the medium to reduce the medium cost one should try to make provision for the alternate and substitute low-cost replacement of certain medium constituents while formulating the production media
* As a matter of fact every component is directly or indirectly influences the economics (costs) of the fermentation process. For example, because of the world political situation, if the availability and cost of cane black-strap molasses becomes too high, one cannot afford to use this as a carbon source. Under such situations there should be provision for an alternative carbon source which is cost effective and made available easily.
* One should remember that sometime the use of an alternate medium requires the use of a different fermentation microorganism or strain of the organism
* Several media need decontamination to remove some contaminated chemical species as they influence the product accumulation and many time make the recovery process difficult. For example, certain metal ions can be removed by ion-exchange resins
* Many media requires pretreatment before they employed. For example, starch must be pre-treated with amylase to release fermentable sugars and proteins must be degraded by proteolytic enzymes to release amino acid for yeasts growth
* Acid or alkali are required to adjust the pH of the medium during production process. As these reagents are not so costly, but considerable reagent may be required for the adjusting the pH value of a large volume of medium which many time lead to a considerable high cost
* Same way, media rich in protein components produce foam and increase the chances of contamination. Under such condition controlling of foam either by chemical antifoam agents of with mechanical device also add the cost of production
* Recovery and purification of fermentation product is very important step of downstream process and markedly increase the overall product cost. Recovery and purification should be fast, easy and should occupy less step with application of low cost chemicals

1. **Fermentation incubation period**

* Fermentation process with short incubation period are less costly compared to processes with prolonged incubation with reference to the inoculum build up and to production.
* One can harvest more batch in case of short incubation period fermentation with a larger turnover of fermentation equipment Fermentation requiring long incubation periods require....

1. additional requirement
2. Extra labor cost
3. have more possibility of getting contamination
4. **Contamination and sterilization**

* Many fermentation processes are more prone to contamination compared to protected fermentation processes.
* For example...

1. fermentations processes in which foaming is the common problem
2. Prolonged incubation requiring processes
3. processes in which the product producing organisms poorly compete with contaminants for fermentation nutrient
4. Processes in which contaminants degrades or chemically change the fermentation products
5. Certain fermentation processes sensitive to lytic phage (for example certain bacterial and actinomycetes fermentations)

* Those fermentation processes in which media sterilization cost is not affordable certain alternative methods to control the growth of contaminants are adapted. These are

1. Adjusting low pH of the medium,

b. Selecting a substrate poorly amenable to attack by contaminants c. Partial sterilization of the medium

d. Selecting certain chemicals which retard the growth of contaminants

* If the fermentation medium is severely contaminated, then it must be discarded and this adds more cost to the production
* Even though the medium is not gravely contaminated and may not be serious enough to discard although also affect the overall yield of the product
* Many time mutation in genetically unstable production strain results in a population of low-yielding cells

1. **Yields and product Recovery**

* High yield and adequate recovery of any fermentation product is of prime importance in any fermentation process. For any fermentation product, high yield with proper recovery and purity affect its position on the open market
* For any fermentation product, to maintain a competitive market position it requires to have continuous research and product development program to improve and increase its yields and a better methods of product recovery. The cost of these important downstream processes very high but extremely important too.

1. **Product purity**

* The purity of fermentation product decides its future stand and long term market value. The costs of product is directly associated to its purity.
* For example, some antibiotic preparations useful for human applications must be sterile and free from pyrogens. On the other hand, some products which are used with other antibiotic preparations, are sold in crude form for mixture with animal feeds
* Some fermentation products can also be marketed at different level of purity and at a more than one concentration For example, lactic acid is sold at strengths ranging from approximately 20 to 85 percent and at purity levels ranging from the relatively crude to high purity edible and U.S.P grades and each of these grades of lactic acid has a place on the market
* Purification steps like solvent extraction and followed by crystallizations for a fermentation product significantly contribute to the overall costs

1. **Labour cost**

* The cost which incur to pay for non-technically and technically trained personal working in any industry at all level of is called labor costs. This include labor related to...

1. Cultures handling
2. Inoculum
3. Production
4. Product recovery and purification
5. Maintenance of product sterility
6. Packaging of the product
7. Steam production
8. Equipment maintenance and cleaning
9. Administration etc.

* This labor costs depends on type of fermentation process (batch of continuous) level of containment to be employed, type of organisms under use (genetically engineered or non-genetically engineered), volume of the product etc.

**vii. Waste disposal and effluent treatment**

* The overall production cost of any fermentation product is influenced by outflow of capital used for waste treatment and disposal and it depends on following two aspects

1. acceptance of fermentation waste with or without pretreatment by municipal waste-treatment facilities or any other local service providers or
2. maintenance of waste water treatment plant by the fermentation

* As per state and federal regulations, it is not possible to dispose fermentation wastes into rivers, streams or any other stagnant water bodies for long time
* In certain case, for example, waste generated in the fermentation processes which exploit plant or animal pathogens as the fermentation organisms requires an additional expense of sterilization before discarding to avoid biohazards There are many sources through which waste is generated. There are...

1. waste generated from the actual fermentation
2. wastes from recovery processes
3. waste form cleaning water
4. waste from cooling waters
5. waste from various staged of product recovery and purification etc

* Many time it is feasible to use waste water for some other purposes, for example, cooling waters can be utilized in media makeup for similar or other fermentations
* Many time, it is possible to recover by-products from the fermentation wastes. For example, riboflavin from the acetone-butanol fermentation
* It is imperative to state that recovery of economically valuable by-products from a fermentation process recover the overall cost and improve profit picture for many fermentation product

**viii.Research cost**

* To maintain a competitive commercial stand, the cost picture of a fermentation process which include expenses incurred in the research and discoveries for the development of the process should be clear
* Many time high cost research without positive outcome in terms of innovations and novelty is of no use for industries facing financial crisis
* Investing in research is a long term venture. It gives incredible financial success provided it is done in a right direction.

Reference

NMEICT-MHRD (Govt. of India) Project on - Creation of e-Contents on Fermentation Technology