International Journal of Applied and
Natural Sciences (IJANS)
ISSN (P): 2319-4014; ISSN (E): 2319-4022
Vol. 6, Issue 4, Jun - Jul 2017; 63 - 70
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International Academy of Science, Engineering and Technology
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# MICROENCAPSULATION OF ALOE VERA OIL FOR PERSONAL HEALTH PRODUCTS–PROCESS OPTIMIZATION

**MEENU SRIVASTAVA & KALINDRI VEMA**

Department of Textiles & Apparel Designing, College of Home Science, MPUAT, Udaipur, Rajasthan, India

## ABSTRACT

Microencapsulation is an effective and important tool to prepare oil-based high-quality and health-beneficial products in various industries in order to enhance their chemical, oxidative, and thermal stability. Present research is based on the development of A. Vera oil micro capsules by process optimization using conservation techniques. The findings of the study revealed that the standardization process of microencapsulation with Aloe Vera oil lead to the formation of miicrocapsules at the optimized ratio 2:4:4 of oil: gum: gelatin, at an optimized 50ºC temperature having initial pH 4.5 and final pH 9.5.

**KEYWORDS:** Microencapsulation, Aloe Vera Oil, Process, Optimization

## INTRODUCTION

In this era, consumers are looking for effective, safe and natural products that contribute to their health, wellness and beauty. Personal care industry invests in innovative technologies and scientific knowledge to put into the market new or updated products that meet the increasingly demanding expectations of consumers. [1-3] Microencapsulation is an effective and important tool to prepare oil-based high-quality and health-beneficial products in various industries in order to enhance their chemical, oxidative, and thermal stability. [4] An essential oil is the volatile lipophilic component extracted from plants. Microencapsulation systems protect the essential oil from degradation and evaporation, and, at the same time, allow a sustained release. [5] The use of medicinal plants is a universal phenomenon. Natural products from plants are rich sources to identify, select and process new drugs for medicinal use.

*Aloe barbadensis, also known as* Aloe Vera *is part of the Liliaceae plant family. Aloe is native to East and South Africa and is grown in most subtropical and tropical locations, including Latin America and the Caribbean. Aloe* sp. (Liliaceae) includes more than 500 species and *A. Vera* is the most commercialized *Aloe* species that are frequently cited as being used in herbal medicine and cosmetic products [6&7] and is a perennial with succulent green leaves joined at the stem in a whorled pattern[8]. The inner clear gel contains 99% water, and the rest is made of glucose, fructose, glucomannans, amino acids, lipids, sterols, minerals, and vitamins[9]. Aloin is the most important glycoside that is produced in leaves [10]

Aloe Vera oil is made from the gel of Aloe Vera plant. There are many species of this succulent plant. The most common one is Aloe barbedensis. Aloe Vera has tremendous health benefits when applied topically and also when used internally [11]. *A. Vera* has been used for many centuries for its curative and therapeutic properties that are due to the presence of compounds such as polysaccharides[12]. Aloe Vera is commonly used for Bacterial, Viral, Fungal and Parasitic Conditions**.** Its Properties are [13]

- Antibacterial
- antifungal/yeast
- anti-inflammatory
- Antimicrobial
- anti-parasite effects
- Antiviral

Microencapsulation is a method in which tiny particles or droplets are surrounded by a coating, wall, or are embedded in a homogeneous or heterogeneous matrix, to form small capsules (Gharsallaoui and others 2007; Calvo and others 2011). It can envelop a solid, liquid, or gaseous substance within another substance in a very small sealed capsule. The core material gradually diffuses through the capsule walls, thereby offering controlled release properties under desired conditions (Fang and Bhandari 2010).

Present research focuses on standardization of the microencapsulation process of volatile oil of Aloe Vera to protect and maintain its stability by conservation technique for its effective application as antibacterial, antifungal finishing in developing various textile products.

## MATERIAL AND METHOD

The raw material used in this study was the essential *Azadirachta indica*, Neem oil and coating materials such as gum Arabic, gelatin. Other materials used were dilute acetic acid, 0.4 N sodium hydroxide solution, gluteraldehyde aqueous solution and sodium sulphate solution.

### Selection of Essential Oil

Essential oils are a complex liquid mixture of volatile, lipophilic and odoriferous compounds biosynthesized by living organisms, predominantly aromatic plants. Berger, (2007). The researcher explored the availability of essential oil-A. There are oiled in the market, to maintain uniformity in quality parameter during experimentation.

### Selection of Wall Material

Gelatine was used as an encapsulating agent, as wall material to encapsulate the inner core material (oil). Preparation of microcapsules by conservation method usually involves a combination of gelatine and a carboxyl bearing polymer. Gum Arabic, a polymer most widely used for complex conservation with a gelatine was used in this process with other naturally occurring polymer and synthetic polymer compatible with cotton fabric and other ingredients in the microencapsulation process based on the past studies.

## METHODS

### Selection of Microencapsulation Technique

Out of the many physical and chemical techniques of microencapsulation i.e. solvent evaporation, polymerization, spray drying, pan coating, phase separation centrifugal extrusion etc. The phase separation-complex conservation technique was selected for present study by the researcher on the basis of review and the suitability of the process to be carried out in the laboratory of the department.

**Complex Coacervation Technique**

Gum acacia was taken as the wall material and essential oil as the core material. Gelatin is the common ingredient in all the processes of complex conservation. The basic recipe (Teli, et.al, 2005) was followed to optimize the various concentrations of the raw material used in microencapsulation process.

## STANDARDIZATION OF MICROENCAPSULATION

The researcher conducted laboratory experiments for standardization of the microencapsulation process by A. Vera oil. The resultant precipitate obtained after each process was analyzed under an inverted microscope to ensure the formation of microcapsules and images were captured. The combination of ratio of oil, gum and gelatin, which produced best results was further subjected to optimization of the other variables. At a time, the ratio of only one variable was varied and other variables were kept constant

- **Optimization of Ratio of Essential Oil:** To optimize the ratio of essential oil, five different ratios of oil i.e. 0.5, 1.0, 1.5. 2.0, 2.5 were taken while other variables, i.e. gum, gelatin, temperature and pH were kept constant to carry out a microencapsulation process. The resultant precipitate obtained was analyzed under an inverted microscope to ensure the formation of microcapsules and optimization was done on the basis of the visual assessment of the microcapsules size, uniformity in size and distribution and wall of the microcapsules on a comparative basis. The ratio giving best results was selected for next stage of optimization.
- **Optimization of Ratio of Gum:** For determination of optimum ratio of gum, five different ratios of gum i.e. 1, 2, 3, 4 and 5 were taken with an optimized ratio of essential oils whereas the ratio of gelatin was kept constant along with all other variables. Microencapsulation was carried out and optimum ratio of gum was optimized on the basis of visual assessment.
- **Optimization of Ratio of Gelatin:** For determination of the optimum ratio of gelatin, five different ratios of gelatin i.e. 1, 2, 3, 4 and 5 were taken with an optimized proportion of oil and gum and all other variables were kept constant. Microencapsulation was carried out and optimum ratio of gelatin was optimized on the basis of visual assessment.
- **Optimization of Temperature:** For determination of optimum temperature for microencapsulation, the process was carried out at six different temperatures, i.e. 30, 40, 50, 60 and 70 degree C with an optimized ratio of oils, gum and gelatin and other variables were kept constant. Optimized temperature was selected on the basis of visual assessment.
- **Optimization of Initial and Final pH:** pH plays very important role in microencapsulation as it is responsible for phase separation which leads to capsule formation. For optimization of pH, the optimized ratio of essential oil, gum and gelatin at an optimized temperature was set to initial pH 4.0, 4.5, 5.0, 5.5, 6.0, 6.5 and 7.0. The microencapsulation process was carried out till gel formation took place and then final pH was maintained at 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10.0 with each initial pH. The initial and final pH was optimized on the basis of visual assessment of microcapsule gel.

## RESULTS AND DISCUSSIONS

### Preparation of Microcapsule Gel

Microcapsule gel was prepared by mixing selected essential oil, gum acacia and gelatin using the complex conservation technique and optimization of various variables, i.e. ratio of essential oil: gum: gelatin, temperature and pH were carried out to obtain the best results.

### Optimization of the Ratio of Essential Oils in Microcapsule Gel

Essential oils form the core material of the microcapsules and is basically responsible for multifunctional properties.

Microcapsule gel was prepared using different ratios of selected clove oil, i.e. 0.5, 1.0, 1.5, 2.0 and 2.5 keeping other variables constant. The gel was observed under an inverted microscope to ensure the presence of microcapsules. The ratio of essential oil was optimized on the basis of visual assessment on three parameters, i.e. size of microcapsules, uniformity in size and distribution and wall of microcapsules.

**Table 1: Optimization of Ratio of Aloe Vera (AV) Oil in Microcapsule Gel**

| eatio of Oil: Gum: Gelatin | Formation of Microcapsules | Parameters | | | |
|---|---|---|---|---|---|
| | | Size of Microcapsules | Uniformity in Size and Distribution | Wall of Microcapsules | Rank |
| 0.5:4:4 | No | - | - | - | - |
| 1:4:4 | No | - | - | - | - |
| 1.5:4:4 | No | - | - | - | - |
| **2**:4:4 | Yes | Medium | Good | Thick and sharp | I |
| 2.5:4:4 | yes | Medium | Poor | Very thin | II |

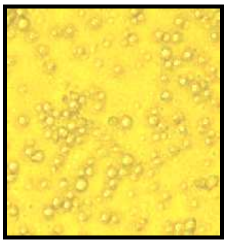


**Image: 1**

**Image: 2**

It is evident from Table 1 and visual assessment of microcapsule gel (Image: 1 to 2) that in case of aloe Vera oil microcapsules were formed in two ratios of oil, gum and gelatin i.e. 2:4:4 and 2.5:4:4. Best capsules were formed in 2:4:4 ratios of oil, gum and gelatin. Hence, ranked 1$^{st}$ indicating medium sized microcapsules with good uniformity in size having thick and sharp walls of the capsules. Thus, the ratio one of aloe Vera oil was used for further optimization to achieve the best results.

### Optimization of Ratio of Gum Acacia in Microcapsule Gel

Gum acacia forms the wall/outer core of the microcapsule and protects the oil from abrasion, sunlight and biodegradation thus provides a controlled release to the oil. Microcapsule gel was prepared using different ratios of gum acacia i.e. 1, 2, 3, 4, and 5.

The data presented in Table 2 and visual evaluation of microcapsule gel (Image: 3 to 5) indicates that microcapsules were formed in only in three ratios, i.e. 2:3:4, 2:4:4 and 2:5:4.

**Table 2: Optimization of Ratio of Gum Arabic in Microcapsule Gel**

| Ratio of Aloevera Oil: Gum: Gelatin | Formation of Microcapsules | Parameters | | | |
|---|---|---|---|---|---|
| | | Size of Microcapsules | Uniformity in Size and Distribution | Wall of Microcapsules | Rank |
| 2:1:4 | No | - | - | - | - |
| 2:2:4 | No | - | - | - | - |
| 2:3:4 | yes | Small | Average | Very thick | II |
| 2:**4**:4 | Yes | Medium | Average | Thick and sharp | I |
| 2:5:4 | yes | Medium+Large | Poor | Very thick | III |

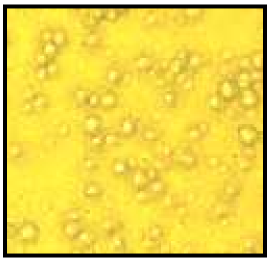


Image: 3

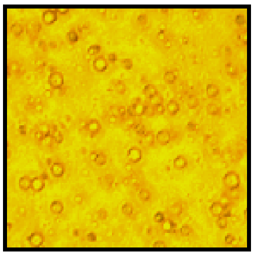


Image: 4

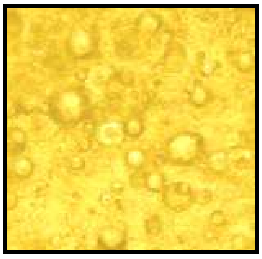


Image: 5

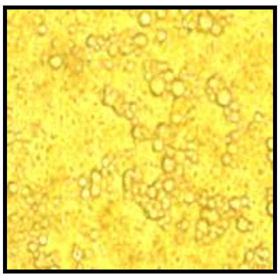
The microcapsules formed in the ratio of 2:4:4 were medium sized, having good uniformity in size and distribution and the walls were also sharp and thick as compared to the capsules formed in the other ratios. Therefore, the ratio 4 was optimized for Aloe Vera Oil.

**Optimization of Ratio of Gelatin in Microcapsule Gel**

Gelatin is a common ingredient of the complex conservation process and gives best results with gum acacia and essential oils. Microcapsule gel was prepared using different ratios of gelatin i.e. 1, 2, 3, 4 and 5.

**Table 3: Optimization of Ratio of Gelatin in Microcapsule Gel**

| Ratio of Aloevera Oil: Gum: Gelatin | Formation of Microcapsules | Parameters | | | |
|---|---|---|---|---|---|
| | | Size of Microcapsules | Uniformity in Size and Distribution | Wall of Microcapsules | Rank |
| 2:4:1 | No | - | - | - | - |
| 2:4:1 | No | - | - | - | - |
| 2:4:3 | No | - | - | - | - |
| 2:4:**4** | Yes | Medium + Small | Average | Thick and sharp | I |
| 2:4:5 | yes | Medium + Small | Poor | Thick | II |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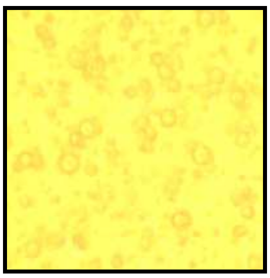
Image: 7

The data presented in Table 3 and visual assessment of microcapsule gel indicate that microcapsules were formed in the two ratios of oil, gum and gelatin i.e. 2:4:4 and 2:4:5 (Image: 6 to7) with Aloe Vera Oil. The best microcapsules formed at the ratio of 2:4:4 which were characterized as medium sized having good uniformity in size and distribution and the thick walls as compared to the capsules formed at other ratios. Therefore, the ratio 4 of gelatin was optimized for further experimentation.

**Optimization of Temperature for Microencapsulation Process**

For optimization of temperature, microencapsulation process was carried out at five different temperatures, i.e. 30, 40, 50, 60 and 70°C.

The data presented in Table 4 and visual evaluation (Image: 12 to14) reveals that the microcapsules formed at 50°C were medium sized, had good uniformity and distribution and the walls were sharp and thick of Aloe Vera Oil.

**Table 4: Optimization of Temperature for Microencapsulation of Aloe Vera Oil**

| Temperature (°C) | Formation of Microcapsules | Parameters | | | Rank |
|---|---|---|---|---|---|
| | | Size of Microcapsules | Uniformity in Size and Distribution | Wall of Microcapsules | |
| 30 | No | - | - | - | - |
| 40 | Yes | Very Small | Average | Thin | III |
| 50 | Yes | Medium | Good | Thick and Sharp | **I** |
| 60 | Yes | Medium+Large | Average | Thick | II |
| 70 | No | - | - | - | - |

Gum:oil:gelatine- 2:2:4

**Image: 8**

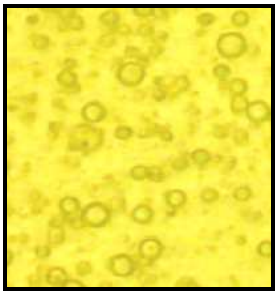

**Image: 9**

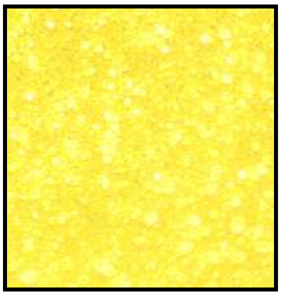

**Image: 10**

Microcapsules were not formed at temperature 30° and 70°C. Hence, 50°C temperature was optimized and used for the development of essential oil microcapsules.

**Optimization of pH for Microencapsulation Process**

To optimize initial pH and the final pH, microencapsulation was carried out with an optimized ratio of oil: gum: gelatin and temperature. Microcapsule gel was initially started at pH 4.0, 4.5, 5.0, 5.5, 6.0, 6.5 and 7.0. After the completion of microencapsulation process, the final pH of the gel was set at 7.0, 7.5, 8.0, 8.5, 9.0 9.5 and 10.

**Table 5: Optimization of pH for Microencapsulation of Aloe Vera Oil**

| pH (Initial / Final) | Formation of Microcapsules | Parameters | | | Rank |
|---|---|---|---|---|---|
| | | Size of Microcapsules | Uniformity in Size and Distribution | Wall of Microcapsules | |
| 4.0/8.5 | Yes | Very Small | Poor | Thin | XII |
| 4.0/9.0 | Yes | Small | Good | Thin | XI |
| 4.0/9.5 | Yes | Large | Average | Thick | IX |
| 4.0/10.0 | Yes | Medium | Average | Very Thick | VII |
| 4.5/8.5 | Yes | Medium + Small | Average | Very Thick | IV |
| 4.5/9.0 | Yes | Medium | Average | Thin + Sharp | III |
| **4.5/9.5** | **Yes** | **Medium** | **Good** | **Thick and Sharp** | **I** |
| 4.5/10.0 | Yes | Medium | Good | Thick | II |
| 5.0/8.5 | Yes | Medium + Large | Average | Very Thick | V |
| 5.0/9 | Yes | Medium + Small | Average | Thick | VI |
| 5.0/9.5 | Yes | Medium | Average | Very Thin | VIII |
| 5.0/10.0 | Yes | Large | Average | Very thick | X |

Gum:oil:gelatin-2:2:4, temperature- 50ºC

As apparent from Table 5 and Image: 11, **microcapsules formed at initial pH 4.5 and final pH 9.5 were medium sized with uniform distribution having thick and sharp walls** in case of Aloe Vera oil Hence, these pH values were used for further experimental work as optimum initial and final pH for the microencapsulation process of selected essential oil.

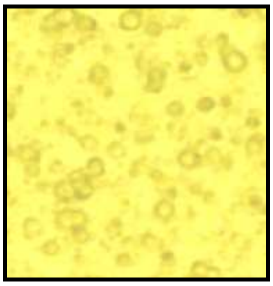

**Image 11: Optimization of pH for Microencapsulation**

## CONCLUSIONS

Micro encapsulation is the cost effective and long lasting method of storing volatile substances over a long period of time. The findings of the present study revealed that the standardization process of microencapsulation with Aloe Vera oil, best microcapsules were formed at the optimized ratio 2:4:4 of oil: gum: gelatin, at an optimized 50ºC temperature having initial pH 4.5 and final pH 9.5. The microcapsules formed with these optimized conditions were observed medium having good uniformity in size and distribution with sharp and thick walls of the capsules.

The standardized microencapsulation process can be effectively used in developing microcapsules gel with Aloe verra oil for its wider applications in personal health care products to derive long term sustained benefit.

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