**INTRODUCTION**

At present scenario vesicular systems have been receiving a lot of interest as a carrier for advanced drug delivery\(^1\). Encapsulation of the drug in vesicular structures is one such system, which can be expected to prolong the duration of the drug in systemic circulation\(^2\). Proniosomes are water soluble carrier particles that are coated with surfactants and can be hydrated to form niosomal dispersion immediately before use in hot aqueous media. Proniosome is a dry free flowing, granular product that could be hydrated immediately before use and would avoid many of the problems associated with aqueous niosome dispersions and problem of physical stability\(^3\). Proniosome technology offers novel solution for poorly soluble drugs. Proniosomes avoid many of the problems associated with aqueous niosome dispersions, and problems of physical stability (aggregation, fusion, leaking) could be minimized. The additional convenience of the transportation, distribution, storage, and dosing would make ‘dry niosomes’ a promising industrial product\(^4\).

Tolterodine tartrate is used for the treatment of overactive bladder with symptoms of urge urinary incontinence, urgency and frequency\(^5\). Use of Tolterodine tartrate is associated with side effects like dry mouth and other side effects like constipation, headache, stomach pain and blurred vision, often leading to discontinuation of therapy\(^6\). The aim of present study includes development of proniosomes of Tolterodine tartrate to reduce dosing frequency and avoid side effects.

**MATERIALS AND METHODS:**

Tolterodine tartrate was obtained as gift sample from Churchbells Pharma Nigeria Limited. Span 60, Tween 40 and cholesterol were procured from Drugfield Pharmaceuticals Limited, Nigeria. Ethyl alcohol and lecithin was procured from Interpharma Industries Nigeria Limited. All other reagents used were of analytical grades.

**Preparation of proniosomal gel:**

Tolterodine tartrate proniosomal gel formulations were prepared by coacervation phase separation method. Precisely weighed amounts of surfactant, lipid phase and drug were taken in a clean and dry wide mouthed glass vial of 5.0 ml capacity and alcohol was added to it. All the ingredients were mixed well with a glass rod; the open end of the glass vial was covered with a lid to prevent the loss of solvent from it and warmed over water bath at 50-60°C for about 5 minutes until the drug is dissolved completely in surfactant mixture. Then the aqueous phase phosphate buffer pH 7.4(1.6ml) was added and warmed on a water bath until a clear solution was formed. Preliminary the composition of these formulations is reported in Table no.2 and they are referred as PG1 to PG4\(^7\).

**Evaluation of proniosome formulations**

**Vesicle size analysis:**

Hydration of Tolterodine tartrate proniosomal gel (100 mg) was done by adding saline solution (0.9% solution) in a small glass vial with occasional shaking for 10 min. The dispersion was observed under optical
microscope at 45 x magnification. The sizes of 200-300 vesicles were measured using a calibrated ocular and stage micrometer (Erma, Tokyo) fitted in the optical microscope.

Drug content
In a 100 ml volumetric flask, 20 mg of proniosomal gel formulations were taken, and volume was made up to mark with pH 7.4. The flask was shaken for 12 hours using an orbital shaker incubator (Finlab, Nigeria). Then the solution was filtered and from the filtrate appropriate dilutions were made and absorbance was measured at 261 nm.

Encapsulation efficiency:
To evaluate the loading capacity of proniosomal systems for Tolterodine tartrate gel (100 mg) was dispersed in distilled water and warmed a little for the formation of niosomes. Then the dispersion was centrifuged at 18000 rpm for 40 min the clear fraction was used for the determination of free drug at 281 nm spectrophotometrically. The percentage encapsulation efficiency was calculated from following equation.

\[
\% \text{ Encapsulation Efficiency} = \frac{\text{Total drug} - \text{Free drug}}{\text{Total drug}} \times 100
\]

pH and Viscosity
Accurately weighed gel was taken and then diluted with the pH 7.4 phosphate buffer and checked the pH by using pH meter (Finlab, Nigeria) and Brook field viscometer is used to determine the viscosity of the gel.

In vitro release study:
In vitro release studies on proniosomal gel of Tolterodine tartrate were performed using locally manufactured Franz-diffusion cell. The capacity of receptor compartment was 15 ml. The area of donor compartment exposed to receptor compartment was 1.41 cm². The dialysis cellophane membrane (MMCO 14KDC) was mounted be Tween the donor and receptor compartment. A weighed amount of proniosomal gel was placed on one side of the dialysis membrane. The receptor medium was phosphate saline buffer pH 7.4. The receptor compartment was surrounded by a water jacket to maintain the temperature at 37±1°C. Samples were withdrawn and were replaced by equal volumes of fresh receptor fluid on each occasion. Samples were withdrawn and analyzed spectrophotometrically (Finlab, Nigeria) at 281 nm.

Stability Studies:
The ability of vesicles to retain the drug was assessed by keeping the proniosomal gel at three different temperature conditions, i.e., refrigeration temperature (4-8°C), room temperature (25±2°C) and oven (45±2°C) for 12 weeks (60% relative humidity). Throughout the study, proniosomal formulations of Tolterodine tartrate were stored in aluminium foil-sealed glass vials. The samples were withdrawn at different time intervals and drug leakage from the formulations was analyzed for drug content spectrophotometrically at 281 nm.

RESULTS AND DISCUSSION:
Results of vesicle size of Tolterodine tartrate proniosome formulations are presented in (Table2), which indicated that vesicle formed with Span 60 is smaller in size than vesicle formed with Tween 40. The reason for this may be higher hydrophobicity of Spans as compared to Tweens. As hydrophobicity increases, surface energy of surfactants decreases, resulting in smaller vesicle size. The size range was found to be 15.28±0.33 to 16.43±0.22 μm. Viscosity of all formulations lies in the range of 7244-9314 cp. Drug content is important parameter to maintain the minimum effective concentration and it is also used to estimate the drug release profile. The percent drug content was higher for PG4 that is 99±0.47% and lower for PG2 (88±0.12%).

In vitro release studies (figure 1) are often performed to predict how a delivery system might work in an ideal situation. The amount of drug released from different proniosomal formulations was found in the order of PG4 > PG3 > PG2 > PG1. In vitro release study were performed on different proniosomal gel formulations shows maximum release for formulations of batch PG4 (87.45%), and minimum for formulations of batch PG4 (50%), after 12 h.

Stability studies performed on optimized formulations PG4 shows 96.74% drug content at refrigeration condition, 94.74% drug content at oven condition and 99.59% drug content at room temperature during the studies performed for 12 weeks on the formulations (figure 2). Thus the room temperature is the favorable storage condition for storage of proniosomes.

CONCLUSION
The results of investigation demonstrated that proniosomes offers an alternative colloidal carrier approach. The results obtained from the present study clearly revealed that Tolterodine tartrate proniosome formulations prepared by using coacervation phase separation method are capable of releasing drug for the extended period of time. Results of the present work have shown that surfactant type affect the encapsulation efficiency and drug release rate from proniosomes. Based on different parameters formulation of batch PG4 was considered as an optimum formulation.

CONFLICT OF INTEREST:
The author has declared that there is no conflict of interest related to this paper.

REFERENCES


### Table 1: Composition of Tolterodine tartrate pronisomal gel formulations.

<table>
<thead>
<tr>
<th>Code</th>
<th>Drug (mg)</th>
<th>Span 60 (mg)</th>
<th>Tween 40 (mg)</th>
<th>Ethyl alcohol (ml)</th>
<th>Lecithin (mg)</th>
<th>Cholesterol (mg)</th>
<th>Observations</th>
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<tbody>
<tr>
<td>PG1</td>
<td>100</td>
<td>-</td>
<td>1500</td>
<td>10</td>
<td>900</td>
<td>200</td>
<td>Yellowish gel</td>
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<tr>
<td>PG2</td>
<td>100</td>
<td>1500</td>
<td>-</td>
<td>10</td>
<td>1800</td>
<td>400</td>
<td>Creamish semisolid</td>
</tr>
<tr>
<td>PG3</td>
<td>100</td>
<td>1500</td>
<td>-</td>
<td>10</td>
<td>900</td>
<td>200</td>
<td>White semisolid</td>
</tr>
<tr>
<td>PG4</td>
<td>100</td>
<td>-</td>
<td>1500</td>
<td>10</td>
<td>1800</td>
<td>400</td>
<td>Yellowish gel</td>
</tr>
</tbody>
</table>

### Table 2: Characterization of the proniosomal formulations of Tolterodine tartrate.

<table>
<thead>
<tr>
<th>Batch Code</th>
<th>Mean particle size (µm)</th>
<th>Encapsulation efficiency (%)</th>
<th>% Drug content</th>
<th>pH</th>
<th>Viscosity (cp)</th>
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<tbody>
<tr>
<td>PG1</td>
<td>15.28±0.33</td>
<td>77.2±0.45</td>
<td>95±0.32</td>
<td>7.12</td>
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<tr>
<td>PG2</td>
<td>8.34±0.45</td>
<td>79.4±0.39</td>
<td>88±0.12</td>
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<td>8247</td>
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<td>PG3</td>
<td>7.27±0.67</td>
<td>81.2±0.48</td>
<td>90±0.77</td>
<td>7.42</td>
<td>9314</td>
</tr>
<tr>
<td>PG4</td>
<td>16.43±0.22</td>
<td>88.3±0.55</td>
<td>99±0.47</td>
<td>7.11</td>
<td>7642</td>
</tr>
</tbody>
</table>
Figure 1: Comparative *in-vitro* release study of different proniosome formulations of Tolterodine tartrate

Figure 2: Stability study of optimized gel formulation (PG4) at different temperature conditions

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