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Innovative and Sustainable Design for Improving the Hygiene in Pharmaceutical Liquid Packaging

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ABSTRACT

Traditional packaging of pharmaceuticals liquid syrup is having lots of constraint of hygiene, accuracy of dose, safely from children and sustainability issues. In this paper, we proposed an innovative design [Indian ordinary Patent Design Application no: 289190] for administering in drug dosing system to facilitate ultimate consumer with greater hygiene, accuracy, easy to use and therapeutically effective amount of drug. This paper is also having emphasis on packaging waste sustainability via development of composite of PET or biodegradable packaging materials for liquid pharmaceuticals packaging system.

Keywords: Hygiene, Pharmaceuticals liquid packaging, Accuracy of dose, Unit dose packaging

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INTRODUCTION

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale and use. A final product is not accepted except it is properly packaged and in some cases the major part of the formulation process may be concern with selecting the correct package for the product. Packaging also refers to the process of design, evaluation and fabrication of packages. A package consists of the container, closure, carton and box components. The container refers in which the final product is enclosed for distribution from manufacturer to consumer. Closure provides tight packing to a container. Carton is used for outer covering, which gives secondary protection against mechanical, chemical and environmental hazards with the provision of multiples of products are packed in it. Designing of package starts with the identification of all the requirements such as structural design, quality assurance, marketing, logistics, shelf life, legal, graphic design, end-use, regulatory and environmental etc. [1]

Pharma Packaging

Function of Pharmaceutical Packaging:

Various elements of the packaging for a pharmaceutical product are designed to ensure that medicines arrive safely in the hands of the ultimate consumer.

In the manufacturing of pharmaceutical products, quality assurance is defined as "the totality of the arrangements made with the object of ensuring that pharmaceutical products are of the quality required for their intended use"[2]. In addition, the system of quality assurance for the manufacture of pharmaceutical products should ensure that "arrangements are made for the manufacture, supply and use of the correct starting and packaging materials" [2]. Public opinion sometimes considers packaging to be superfluous and cost increasing. However, it must be emphasized that packaging preserves the stability and quality of medicinal products and protects them against all forms of spoilage and tampering. The stability of a drug formulation prior to delivery can be affected by many factors - the major factors are formulation dependent and packaging dependent. The primary factor affecting drug stability is the interaction of the pharmaceutical drug formulation with leachables/extractables or permeating gas species during storage. During storage, glass, polymer, elastomer, and metal packaging components may release species (e.g. Na+, K, Al3 +, SiOHn" 4-n, stearic acid, calcium stearate, 2, 6- di-tert-butyl-4-methylphenol) that interact with various components of the drug formulation or allow the permeation of gaseous species such as oxygen or carbon dioxide. For example, when storing water for injection in Type 1 glass alkali ion exchange causes the pH to change. Barrier coatings,

such as SiO2, to reduce the exposure of drug solutions or components thereof to ion exchange and/or various gases, have been produced via plasma enhanced chemical vapor deposition methods to minimize the release of glass constituents into drug formulations; for example patent no: DE19629877 M. Walther et al.; EP0821079 M Walther et al.; DE4438359 M. Walther et al.; EP0709485 M. Walther et al. and DE29609958 M. Walther et al.

All medicinal products need to be protected and "consequently need to be packaged in containers that conform to prescribed standards, particularly with respect to the exclusion of moisture, light, prevention of leaching of extractable substances into the contents and of chemical interaction with the contents. However, the limits of acceptability in these various respects depend at least in part on climatic variables. Recommendations in The international pharmacopoeia can only be advisory; precise quantitative standards will have to be locally determined" [3].

The complexity of packaging materials and the highly technological nature of medicinal products are such that manufacturers are confronted with significant problems. Interaction between packaging and such products is possible due to the combination of a multiplicity of container components and active pharmaceutical ingredients, excipients and solvents used in a variety of dosage forms.

The kind of packaging and the materials used must be chosen in such a way that, the packaging itself does not have an adverse effect on the product (e.g. through chemical reactions, leaching of packaging materials or absorption) changing its properties or affecting its protective function.

Pharmaceuticals Packaging Materials:

Types of Materials	Use
Glass	Bottles, vials, ampoules, syringes, aerosol containers.
Plastics	Bottles, syringes, tubes, bags, laminates, pouches, lids, taps, stems, aerosol containers.
Rubbers	Closures, vial wrappers, caps, plungers.
Paper/Cardboard	Labels, inserts, display units, pouches, laminates, cartons, boxes, foil, gum tapes, paper drums.
Metals	Collapsible tubes, foils, needles, aerosol containers, cans.

Pharmaceuticals Syrup Packaging:

Syrup, as a pharmaceutical product requires safe, secure and tamper-proof handling during its shelf life or until consume. Packaging of syrup needs to ensure complete protection from contamination and microbial growth. Proposed inevitable packaging system assures the safe and secure packaging of syrups along with to ensure shelf life.

In the past few years back syrup packaging came in the glass bottles but due to major concern with glass like inconvenience in handling, fragile, high in weight, brittle in nature etc. In the present glass is replaced with plastic bottles in syrup packaging like PET, HDPE etc. in the quantity of 100ml, 200ml, 300ml or non-standard packaging volume.

Liquid dosage forms:

Liquid drug formulations for oral drug administration are available as solutions, syrups, emulsions or suspensions. Homogeneous liquids like solutions or syrups with completely dissolved API have advantages over emulsions and suspensions as they ensure uniform doses when withdrawing single doses out off a multi-dose container. Single-dose containers for oral liquid medications could be sachets or stick-packs, but they are currently not available in the market. Therefore, for accumulating dosing approaches (Figure 3) only dropping bottles and spoon are considered in this study. Partition dosing approaches require measuring or counting tools. It can be distinguished between tools which are part of the primary packaging such as dropper inlets or dropping tubes and separate dosing devices like dosing spoons, cups, dropping pipette sand oral syringes.

Structure for Single Dose Liquid Syrup:

Liquid syrup is comes in two form one have the low viscosity which can easily come out completely by tilting bottles without any external arrangement and second one have the high viscosity which cannot comes out completely by tilting the bottles some amount of drug still remain in the bottle for removing this type of problem. In this present research work, we develop the design for with injectable cap or pin (this is for having high viscosity syrup).

Advances in dosing devices:

Dosing devices for drug delivery may be provided with the package or separately provided with package. Typical target dose volumes are ≤5ml for children under 5 years and ≤10 ml for those of 5 years and older. In former times dosing with a teaspoon or a tablespoon was assumed to provide acceptable doses. However, as modern spoons may have different shape and volumes, dosing with household spoons is considered as inappropriate today [4]. For liquid dosage forms that require administration with a measuring device, it is important that graduations on the dosing device are clearly visible (e.g. embossed or printed) to enable accurate and precise dosing to patient. In this phenomenon of pharmaceutical packaging development, physical characteristics of the liquid in relation to the proposed dosing device must be considered. The shape of the measuring device scan affects dosing accuracy. Indeed, dosing devices with a small base area appear to have better accuracy than those with a broad base area. Graduations on

dosing spoons used to measure doses less than 5ml can lead to inaccurate and variable dosing (Figure 1).

Figure 1: Problem facing by current packaging of syrup

In the present technological age, there is a huge need for the development of novel dosage forms and delivery devices for oral individual drug therapy. However, practical implementation and clinical studies are still missing, but needed to prove the quality and success of these concepts. The only practices commonly used are dosing liquids by droppers, spoons and syringes or splitting tablets into segments, but this bears various risks as continuously claimed by different organizations. Dispensers for multi particulate dosage forms have been developed but up to now there is only one dispenser for pellets available on the market with minor dosing flexibility. More advanced delivery devices have been proposed, but did not reach the market most probably due to financial reasons. The recently introduced concept using a solid dosage pen may serve as a future platform technology for completely individual choice of doses. Systems which will be investigated in clinical studies should allow a therapy of all subpopulations, including children. Devices like the solid dosage pen or the electronic dispenser for film strips would lead to novel standards for oral drug dosage forms in the regulatory procedures. However, up to now only different insulin formulations and some other biotechnological parenteral formulations for application with pens have been authorized for individualized drug therapy. An advantage of these advanced concepts could be an authorization for children and adults with only one dosage form and delivery device.

Issues with Syrup Packaging

The pharmaceutical industry is the growing industry all over the world and requirement of drug is continuously increasing day by day due to different health related problems. In terms of the global market and increasing demand of drugs, we need to conserve our natural resources so that our next generation will have a better tomorrow [5,6].

Our approaches are based on two important factors, one is hygienic and second is sustainable development in pharmaceutical liquids packaging. Generally we have seen that doctors prescribed the different medicine, some medicines are in the solid tablet form and some are in liquid form. In this approach, scientific focuses on liquid form of medicine like syrup.

According to the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases''.

Figure 2: Contamination of syrup bottle due to contact with ants and environment

Figure 3: Syrup delivery by spoon (source of unhygienic and inaccuracy of dose)

Constraint of present Syrup packaging system

Syrup, generally available in market are in the form of bottles of different quantity like 100ml, 200ml, 300ml etc. and patient force to buy the full bottle of syrup and start consuming as per doctor's prescription. Syrup dose generally vary like 10ml, 5ml or 2.5ml each time and 2 to 3 times in a day and generally patient measure and take the quantity by measuring cup, which is mounted on top of bottles. Each time a patient takes the required quantity by measuring cup, it

again mounted on top of the bottle washing with normal water or sometimes patient do not wash this cup. By this procedure of consuming the syrup by patient, there is some critical point which impact on patient health;

- When washing the measuring cup with normal water then measuring cup is contaminated by some bacteria, those are present in the water as well as environment.
- If do not wash the measuring cup then ants may gathered around and inside the measuring cap and contaminated the measuring cup. Then it is creating unhygienic condition for drug to consume by patient.
- Generally, it is in practice that patient buy the full syrup bottle of above mention quantity. It was also found that patient cure before finishing the bottle of syrup. Then patient discontinued the syrup, so remaining syrup stored in home for some times but at the end we throw the bottle in the garbage. Then remaining quantity totally going to waste, so there is sustainability and loss of resources is concern for new innovation for dosing system.

Taking into account all above point we have developed an approach for packaging of liquid pharmaceuticals syrup. In this present study, we recommended the development of new innovative design for separately for different quantity like 2.5ml, 5ml and 10ml. These new designs are generally single dose like use and through type. Due to this novel design, syrup will not be contaminated by environment and water and also there would not be any requirement of measuring cup. This novel design would also provide therapeutically effective amount of drug to the patient in an efficient mode. This design for syrup is also suitable for large-scale manufacturing, which helps to overcome some of the deficiencies of existing packaging system.

Waste disposal of Packaging Materials

The Union health ministry has banned the use of plastic bottle containers in pharmaceutical industry. According to the recent notification by the health ministry, no manufacturer shall use the polyethylene terephthalate (PET) or plastic containers in liquid oral formulations for primary packaging of drug formulations for pediatric use, geriatric use and for pregnant women of reproductive age.

The pharmaceutical companies have been given a transition period of six months. Earlier packaging industry had expressed objections. However, following recommendations given by the Drug Technical Advisory Board (DTAB), which is government's highest decision making body on drugs, the health ministry's decided to impose a ban. The recommendations were in line with

the concerns expressed by an expert panel that expressed serious issues of health hazards because of use of PET bottles in pharmaceuticals industry.

Significance of hygiene in Pharmaceuticals Packaging:

"According to the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases"

It is consider as one of the important factor of our day to day life at home as well as at workplace. In pharmaceutical, hygiene pertain to the hygiene practices related to the administration of drug and medical care that prevents and minimizes disease and spreading of diseases. In pharmaceutical packaging, it was observed that most of the concern due to multidose form of drugs. Patient taking the drug from multidose containers of drug and due to insufficient resalable capacity of containers, it becomes in contact with environment and environmental bacteria. Other factors such as dust, dirt, ants also gathered on the container which promotes unhygienic conditions favor's hazardous ambient conditions.

Innovative design for Liquid Pharmaceuticals Packaging

Innovative design for liquid drug packaging may help to removing the health related problems due to maintain hygiene and safety. Present new innovative approach help to reduce the environmental contact with containers due to unit dose packaging system.

These unit dose containers is like use and throw, so there is no chances of gathering dirt, ants or other environmental factors on the packaging containers. When liquid drugs comes in unit dose packaging then patient will buy only required quantity of drugs, which will helps to reducing the wastage of drug as well as money of the patient .

Design without Injectable Cap or Pin:

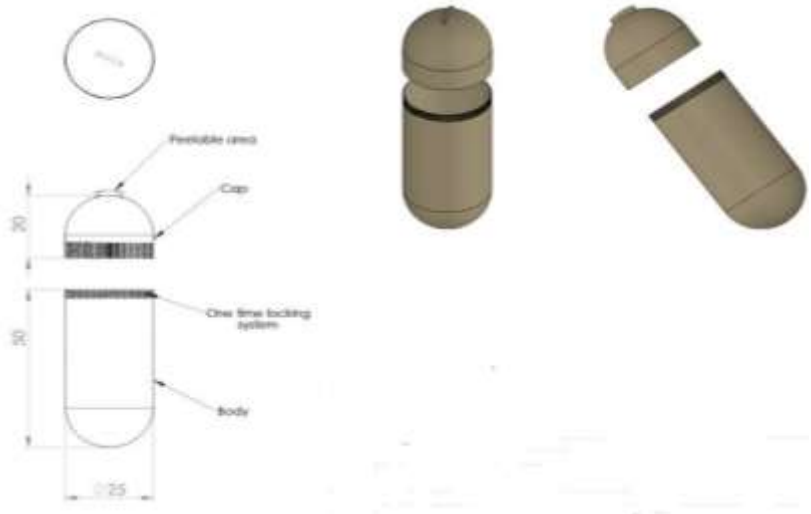

Figure 4: (Dimension given in design is taken approximately for 10 ml liquid syrup)

Design Description:

This innovative design contains two separate parts as cap and body. Cap is also having the provision for filling the drug from form fill and seal machine (FFS).

Figure 5: Complete design

Cap:

Cap has spherical shape on the top side because spherical shape is the most stable shape. On the top side of the cap there is some portion is peelable area, which can be peeled off by pulling it with mild pressure. By peelable area drug is comes out and can directly take inside the mouth. Lower part is the cap has inner sealing area which is completely sealed with body sealing area.

Figure 6: Cap

Body

Body also has spherical shape in lower side. In lower side of the body part, there is outer side sealing area which is completely locked with the cap. The sealing area of the both part locked each other and this lock is one time lock after filling the drug. Maximum quantity of drug is hold by body part.

Figure 7: Body

How design will improve the Hygiene:

This present innovative design is milestone in replacement of syrup packaging into unit dose packaging system. In this innovation, design modification for consuming the syrup as per convenience of age group as well as flow characteristics of drug. In this innovative design we recommend that upper/lower part of unit dose will be peelable with simply twisting with the help of knob from upper/lower part. This design is very suitable for lower viscous liquids for consuming.

Survey for validation of hygiene from innovative design:

A survey was conducted for validation of design for improves the hygiene with comparison to traditional ways of drug ingestion. Result of survey was concluded that 95% of peoples (Men-93%, Women-97%) were agreed that proposed innovative design will improve the level of hygiene. Total 100 nos of sample were collected for this survey within the age group of 18-60.

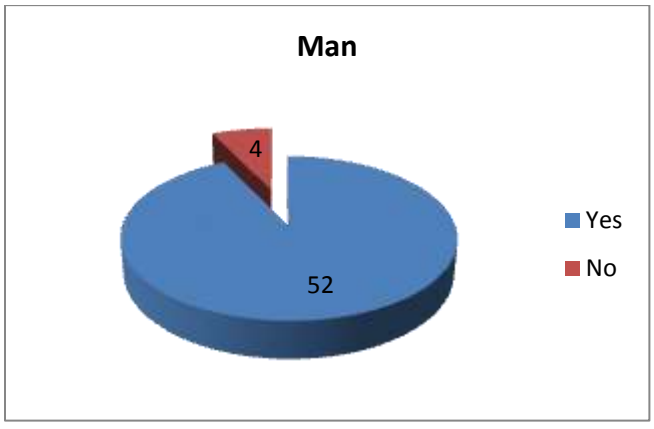

Figure 8: Illustrate that 93% of men agree with

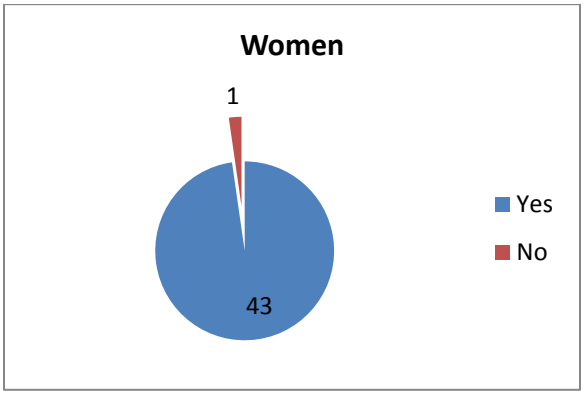

Figure 9: Illustrate that 97% of women agree with

CONCLUSION:

Therefore, it may be concluded that present proposed innovative novel design Indian ordinary Patent Design Application no: 289190 is milestone for pharmaceuticals liquid packaging system. By adoption of proposed design, excellent level of hygiene can be maintained because of use and through type unit dose packaging system. Other than hygiene factor, this design is also having advantage of accuracy of dose quantity, easy to consume and wastage of remains drug at home. In proposed design, it may be possible that quantity of packaging materials per unit dose may not be proportional with single bottle. But proposed design can save the drug quantity as well as carbon foot print for entire supply chain. This novel design would also provide therapeutically effective amount of drug to the patient in an efficient mode. This design for syrup is also suitable for large-scale manufacturing, which helps to overcome some of the deficiencies of existing packaging system. It was also found that mainly all liquid pharmaceuticals bottles made of poly ethylene terephthalate. This present study may also further expansions for replacement of polyethylene terephthalate with biodegradable composite materials for bottle manufacturing. Then, it may open new approach for sustainable developments in pharmaceuticals liquid packaging.

FUTURISTIC RESEARCH:

Across the globe, recycling of plastic materials is a challenging task, because of plastic materials are very destructive for our environment. Generally peoples use the product and throw the packaging materials in the bin. These plastic materials decompose very slowly or if we burnt them they releases very toxic gases like methane, carbon di oxide, dioxins and furans. These gases may cause cancer, impotence, asthma and a myriad other allergies to human beings.

Conventional polymers such as polyethylene and polypropylene persist for many years after disposal. Built for the long haul, these polymers seem inappropriate for applications in which

plastics are used for short time periods and then disposed. Furthermore, plastics are often soiled by food and other biological substances, making physical recycling of these materials impractical and generally undesirable. In contrast of present design and development, biodegradable polymers (BPs) disposed in bioactive environments degrade by the enzymatic action of microorganisms such as bacteria, fungi, and algae may be suggest for future development.

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