

Minutes of the sub group (farm sector) meeting discussing "Turmeric technologies (Processes, Products & Avenues) for economic benefit for NER", held on Wednesday, 30th August, 2017 at O/o the PSA to GOI, Vigyan Bhawan Annexe, New Delhi-110011.

A meeting to discuss Turmeric technologies (Processes, Products & Avenues) held on 30th August, 2017 was chaired by Dr. R. Chidambaram, PSA. The meeting was attended by the Secretary Ministry of DONER, Joint Secretaries M/o DoNER, Senior Scientists, Directors representing BARC CSIR, ICAR. The list of participants & Agenda of the meeting are placed at Annexure 1.

2. Chairman Dr. R. Chidambaram, PSA, welcomed all present to the meeting. He said that STINER (S&T Interventions for North East Region) initiative by M/o DoNER could go a long way towards developing technology solutions in prioritized Turmeric (farm sector) and Textiles (non-farm) sectors. This particular meeting was focused on Turmeric which has both nutraceutical and pharmaceutical properties that can be part of value addition. It could be a good element for fortification of food which is a concern of Government now. He cited in this regard the work planned under the leadership of Dr Soumya Swaminathan on nutrition for children and pregnant women as part of an initiative of PSA's office.

Turmeric could also be seen as a therapeutic ingredient. He added that upgraded technologies with better processing and value addition for turmeric would help NER farmers to fetch better prices for the products. He mentioned that, CSIR, BARC, ICAR and other Scientific departments have developed various technologies, machinery, for turmeric/ginger processing. He said that IIT Kharagpur would be the nodal institution developing and executing required turmeric technologies for NER under STINER and requested Dr. Ketaki Bapat to share the updates on STINER meetings.

3. Dr. Ketaki Bapat, O/o the PSA to GoI, mentioned that till date three STINER meetings dated 20.04.2017, 12.05.2017 and 18.05.2017 have been conducted and briefed the group on the actions suggested by the committees: a) ICAR could play a greater role in sharing technologies to the farmers and would make variety of **improved seeds** available to NER farmers, after receipt of the demands from MD, NERAMAC. b) CSIR should play important role in **development of labs, collecting data** relating to the existing facilities for different purpose and create quality testing facility at the earliest. c) In addition CIMAP, NBRI may work out a joint programme for **maximising the value** from turmeric including processing of turmeric leaves.

4. Shri Naveen Verma, Secretary, M/o DoNER mentioned that turmeric with high curcumin content with a good nutraceutical potential is grown in North East and though the technologies for turmeric processing are available, they have been disseminated only to a limited extent. He said that, through STINER, appropriate S&T interventions required for NER are being worked out.

5. Mentioning the use of ICT, Shri S.N. Pradhan, Joint Secretary, M/o DONER said that creating STINER portal would be very useful and informed that essential MOUs are being prepared to formalize the STINER initiative with stake holders.

6. Shri Jitendra Kumar Sinha, Joint Secretary, M/o DONER specially mentioned the actionable points suggested by the committee during the meeting held on 12.05.2017, following aspects which related to Turmeric in the North Eastern Region were discussed.

- The CSIR and ICAR both have technology for extraction of active compounds i.e. Curcumin and Oleoresin from turmeric which has high demand in foreign Countries.

8b. Chairman recalled the discussion with Director BARC, mentioning about Banana Tissue Culture (BTC) technique developed by NABTD, BARC. He said that Dr. B.S Tomar, Director, RC&I Group, BARC would be visiting North East in September, 2017 and a meeting with concerned officials and agricultural university scientists may be arranged with the help of M/o DoNER, to explore the possibility for BTC in NER.

8c. Chairman shared that a refrigeration system developed by RRCAT Indore could be tried out in NER for transporting post-harvest produce.

8d. It was felt that end-to-end cycle for turmeric along with impact studies for longer duration could be demonstrated at select states of NER. The study would consider planting appropriate turmeric variety, value added turmeric products and other related aspects.

9. **Recommended Action points for Road Map Turmeric (farm sector)–(STINER):**

- a) It was decided that the Nodal officers of various stake holding scientific aegis in STINER, who should consistently attend STINER meetings representing CSIR, Spices board, BARC and ICAR would be: CSIR- Dr. Sudeep Kumar, Spices Board- Dr. A.B Remashree, BARC-Dr. Indira Priyadarshini, ICAR - Dr. T. Janaki Raman and Dr. S.N Jha, New Delhi and participation request should be sent to them to attend the STINER meetings.
- b) It was decided that the steering group in farm sector for NER would be chaired by Director, IIT Kharagpur. It would develop, upgrade and ensure timely delivery of the required turmeric technologies. IIT Kharagpur would also be the developer, custodian and curator of the STINER portal which should act as a one stop point for STINER related knowledge, developments, queries and resolutions for all stakeholders.
- c) The study on pregnant women/children, in the context of nutrition, can be conducted in NER and M/o DoNER would identify the target livelihood groups for the study conducted by ICMR information would be sent to Dr. Soumya Swaminathan, DG, ICMR by the O/o the PSA.
- d) A refrigeration system developed by RRCAT Indore could be tried out for transporting post-harvest produce at NER.
- e) With the help from M/o DoNER, a meeting with concerned officials /scientists would be convened in September 2017 to explore the possibility of Banana tissue culture developed by BARC at NER. *(The meeting has been already convened on 15th September, 2017 and Dr. T Ganapathi, NABTD, BARC presented the technology to the concerned officials and scientists.)*
- f) **Turmeric planting material:** The impact of S&T intervention for turmeric would be studied in Sikkim and Mizoram states of NER. ICAR would supply turmeric quality seed material to the selected areas of these states and KVKs, state Agricultural University would be actively involved. The study would be supported by the O/o PSA to GOI.

Action: ICAR would send a project proposal to O/o PSA and livelihood groups of NERCOM and NERLEP would help in identifying field locations.

Meeting of sub group (farm sector) discussing "Turmeric technologies (Processes, Products & Avenues) for economic benefit for NER" on Wednesday, 30th August, 2017 at O/o PSA to GOI, New Delhi-110011.

List of Participants :

O/o PSA to GOI

- Dr. R. Chidambaram, PSA to GOI
- Dr. Swati Basu, Scientific Consultant, O/o PSA to GOI
- Dr. Ketaki Bapat, Scientist 'F', O/o PSA to GOI

Ministry of DoNER

- Shri. Naveen Verma, Secretary DoNER
- Shri SN Pradhan, Joint Secretary, DoNER
- Shri Jitendra Kumar Sinha, Joint Secretary, DoNER
- Smt. Mercy Epao, Director, DoNER

Invitees

- Prof. Partha P. Chakrabarti, Director-IIT Kharagpur
- Prof. P.B.S. Bhadoria, IIT Kharagpur
- Prof. A.K Datta, IIT Kharagpur
- Dr. T. Janakiram, ICAR, New Delhi
- Dr. S. N. Zha, ICAR, New Delhi
- Dr. Sanjay Kumar, IHBT CSIR
- Dr. S.K. Barik, NBRI, CSIR, Lucknow
- Dr. Ajit Kumar Shasany, CIMAP, CSIR, Lucknow
- Dr. Indira Priyadarsini, BARC, Mumbai
- Dr. Sudeep Kumar, Mission Director, CSIR, New Delhi

Agenda

Meeting of sub group (farm sector) discussing- Turmeric technologies (Processes, Products & Avenues) for economic benefit for NER.

Day/Date : Wednesday, 30th August, 2017

Time : 11.00-13.30 hrs.

Venue : RoomNo. 319A, O/o PSA to GOI,
2nd Floor, Vigyan Bhawan Annexe,
Maulana Azad Road, New Delhi-11

- **Welcome & Opening Remarks**
Dr. R. Chidambaram, PSA to GOI
Shri Naveen Verma, Secretary, M/o DoNER
 - **Brief Presentation and Discussion (20 min. each)**
(Each ppt-10 min. followed by discussion-10min.)
 - ✓ M/o DoNER
 - ✓ CSIR
 - ✓ ICAR
 - ✓ IIT Kharagpur
 - ✓ BARC
 - ✓ Spices Board
 - **Suggestions and Action Points**
- Lunch



**Turmeric Technologies:
BARC INITIATIVES**

Dr K Indira Priyadarsini
Chemistry Division
BARC, Mumbai-400085
E-mail: kindira@barc.gov.in


Meeting on "Turmeric Technologies (Processing, Products & Analysis) for Economic Growth for MSME"
Wednesday 28 Aug 2017, Dr. K. Indira Priyadarsini, New Delhi








Tumeric (Haridra, Curcuma longa);

- Turmeric is cultivated in tropical and subtropical regions ; India is the largest producer of turmeric.
- Known since ancient time; Mentioned in Rigveda/Uthava Veda as Golden root to overcome evils
- According to Ashtanga Samgraha; Haridra is the best Ayurveda medicine for treatment of all the metabolic disorders like diabetes
- Used Regularly in Indian Cuisine
- Consumed both internally and externally
- Low rates of Alzheimer's among rural Indians. Mainly attributed to their high consumption of turmeric



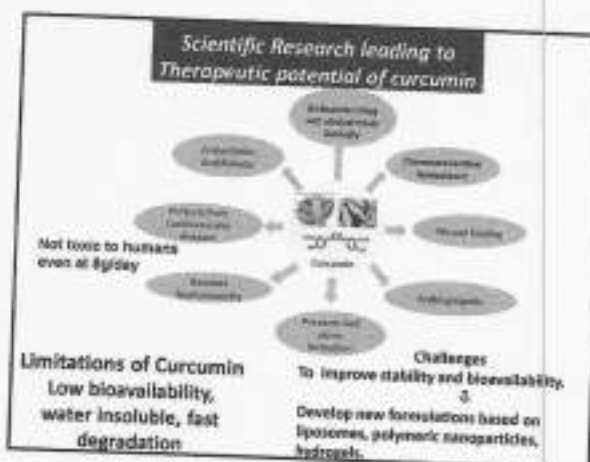
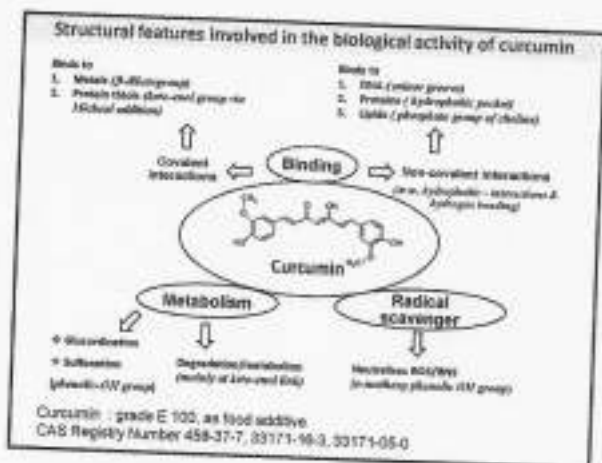
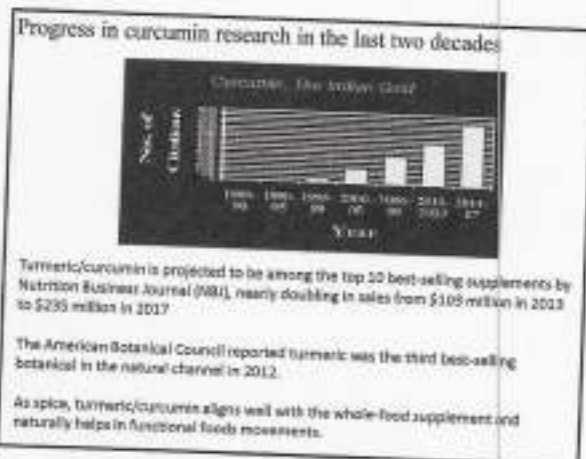
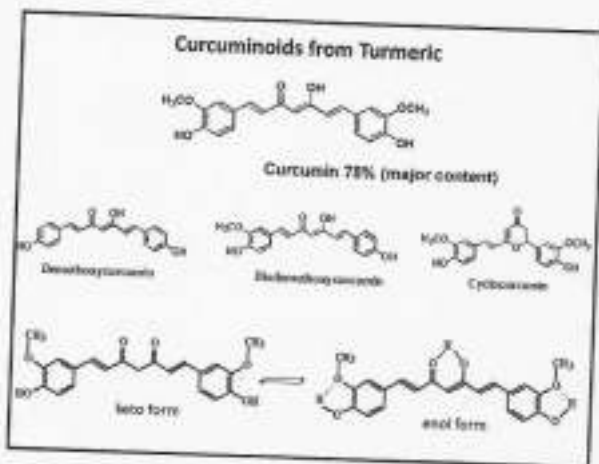
  

What are the ingredients of Turmeric?

- Diaryheptanoids (yellow pigments) known as curcuminoids- 2-9%
- Essential Oil (3--5%) - Antimicrobial, Anti-inflammatory, anti-tubercular, (antileprotic)
- Tannins - Antioxidant, antineoplastic, protects DNA (very useful protein product)
- Ubiquinol - Antioxidant (activates white blood cells)
- Ubiquinol - D - Inhibits carcinogens
- Oleoresins
- Vitamin A, carotenoids, minerals

Turmeric, based products in international market





Curcumin research from our laboratory

Anti-oxidant effects

- Excellent Free radical scavenger
- Protects biomolecules from oxidative stress
- Anti-haemolytic activity

SCC mimics


- Synthesis of curcumin-copper complex
- In vitro evaluation
- In vivo Evaluation

Anti-tumor effects

- Preferential uptake by tumor cells
- Selective toxicity in tumor cells

Binding to biomolecules

- DNA (minor groove)
- Proteins (Hydrophobic pocket)
- Lipid (non polar tail)



Curcumin

Synthesis of active derivatives & formulations

- Dihydroxy curcumin
- Dimethyl curcumin
- Curcumin Pyrrole
- Tetrahydro curcumin
- Curcumin pills
- Nano-Curcumin
- Curcumin hydrogels
- Turbovita

Curcumin Research from Our Laboratory

Synthesis & evaluation of novel active curcumin derivatives


Proc Natl Acad Sci U S A 2007;104:1040-1045
Proc Natl Acad Sci U S A 2007;104:1040-1045

Interaction of with various cells using the DNA-protein-lipid-curcumin complex

Anticancer Chem. Therapeutics: Drug Development/Target Identification
Biorg Med Chem Lett 2002;13:2025-2028

Review articles

Anticancer Chem Therapeutics 2007;10:1040-1045
J Pharm Sci 2007;96:1040-1045
Proc Natl Acad Sci U S A 2007;104:1040-1045
Int J Pharm 2007;350:1040-1045
Chem Biol Drug Design 2007;11:1040-1045



Curcumin

Synthesis & evaluation of Curcumin-Lipid complex

Proc Natl Acad Sci U S A 2007;104:1040-1045
J Cell Biochem 2007;104:1040-1045
Eur J Med Chem 2007;52:1040-1045
J Biol Chem 2007;282:1040-1045

Formulations


Chem Biol Drug Design 2007;11:1040-1045
Phytochem Pharmacol 2007;10:1040-1045
Chem Biol Drug Design 2007;11:1040-1045
Int J Pharm 2007;350:1040-1045
Chem Biol Drug Design 2007;11:1040-1045

Turmeric based nutraceutical formulation (turbovita) from BARC


- > Scientifically researched supplement
- > Along with necessary nutrients, the supplement has turmeric extract, expressed in terms of curcumin content
- > It has all the beneficial effects of curcumin
- > The stability and bio-availability of curcumin in the supplement is enhanced

Turbovita is developed in collaboration with MVA Verna Industries, Nagpur, under ERDC-sponsored technology commercialization.


Lab scale preparation of Turbovita




Dry plant powder




Extraction




Solid extract




New formulation



Necessary nutrients



Dry powder



Bio-available form

Three varieties of turmeric were tested; The source from Assam showed highest curcumin isolated & developed by BARC in collaboration with MVA Verna Industries, Nagpur.

Pilot scale preparation of TurboVita



Ingredients in TurboVita

- | | | | |
|-------------------------|---------------|--------------------|-------------------------|
| • Sunflower oil | • Citric acid | • Sorbic acid | • Vitamin C |
| • Calcium D-Glucate | • Malt | • Zinc L-Aspartate | • Tri-calcium Phosphate |
| • Beet Protein Isolate | • Magnesium | • Vitamin B-2-B-6 | • Shell Calcium |
| • Wheat Protein Isolate | • Zinc Powder | • B-Group Vitamins | • Fats |
| • Citric Acid | | | |

Benefits of TurboVita

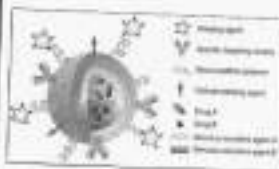
- 1 TurboVita is a unique pharmaceutical formulation containing blend of highest quality of proteins, carbohydrates, fats, fibers, vitamins and minerals along with turmeric, approved as natural content.
- 2 The stability and bio-availability of nutrients in TurboVita is enhanced.
- 3 TurboVita can be consumed regularly by normal public & patients undergoing treatment.



Nano formulations for biomedical applications

Biocompatible nanoparticles

- Metal Based: Au, Ag
- Oxide based: Fe₃O₄, SiO₂, ZnO, Hydroxyapatite
- Lipid based: Liposomes, fatty acids, triglycerides
- Polymer based: Chitosan, alginate, surfactants, block-copolymer
- Biological: Proteins, peptides, mRNA



Advantages of nanoformulations

- ✓ Improve Solubility/Biocompatibility
- ✓ Alter Biodistribution
- ✓ Controlled Release
- ✓ Site-specific targeting

Nanoparticles of size from 25 to 100 nm are suitable for biomedical applications

Nano Curcumin formulations from our group

(http://www.indofarmaceutics.com/nano_applications/index.html)

• All the excipients employed are either food grade or FDA approved.

♦ Purpose:

To develop nutraceuticals, targeted drug delivery, combinatorial therapy

Development of albumin based protein nanoparticle

Objectives

- Preparation of albumin based delivery system for drug delivery
- Albumin nanoparticles are non-toxic and precisely target tumor through enhanced permeability and retention effect

Protein in PBS solution $\xrightarrow{\text{Heat}}$ Aggregates

Characterization: DLS, zeta potential, viscosity, circular dichroism and absorption measurements

Method	Time (min)	Wavelength (nm)	Concentration (mg/ml)	Cell uptake (fold increase)
UV-Vis	10	280	0.1	1.0
DLS	10	300	0.1	1.0
Zeta	10	300	0.1	1.0
CD	10	220	0.1	1.0

Uptake of curcumin by A549 cells was lower in the 100 nm sized than in nanospheres as compared to the native form.

Native to nanoparticle transition probed by DLS

Development of G-protein nanoparticle (GN)

Protein nanoparticles are prepared by the thermal denaturation

Native protein $\xrightarrow{\text{Heating}}$ Aggregated protein $\xrightarrow{\text{1. Purification, 2. Heating}}$ Protein/nanoparticle (GN) (100 nm - 300 nm)

Characterization: DLS, zeta potential, viscosity and absorption measurements

Size of GN decreases with decrease in hydrophobicity (PAB) value of phenolic

Coating efficiency of GN increases with decrease in PAB value of phenolic

Curcumin uptake higher in GN as compared to curcumin dissolved in DMSC

GN with phenolic having higher PAB shows more curcumin uptake

Hydrogels loaded with curcumin

Absorbed dose: ~13 kGy for hydrogel formation

~200 nanomoles of curcumin loaded per gram of hydrogel

PVA

Useful for treatment of superficial burns

Releases curcumin slowly in liposomes

Current Science 296 (2008) 1435-1442

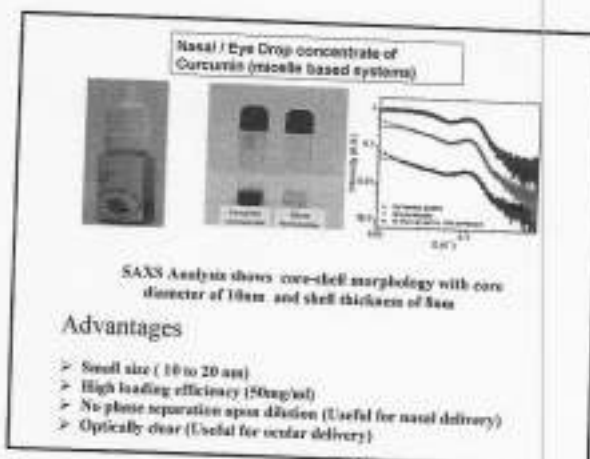
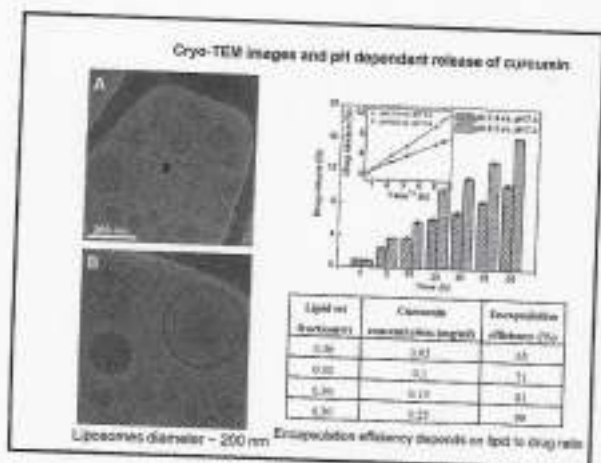
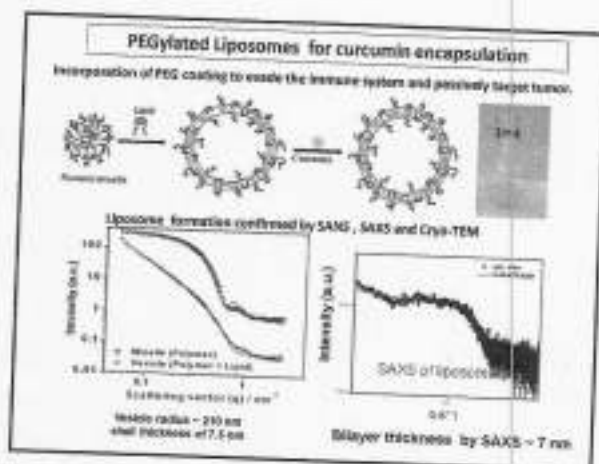
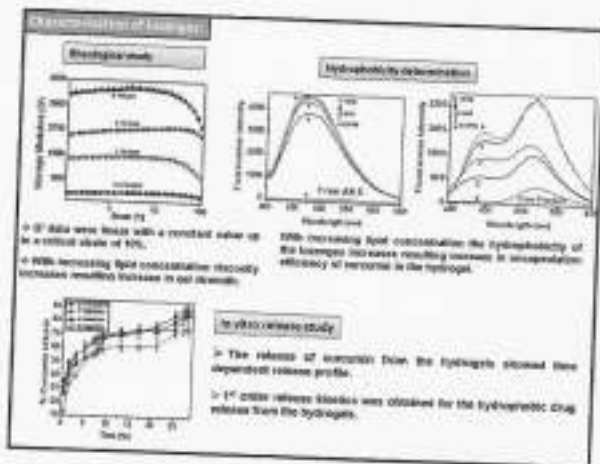
Curcumin-polymer hydrogels for oral effective anticancer drug application

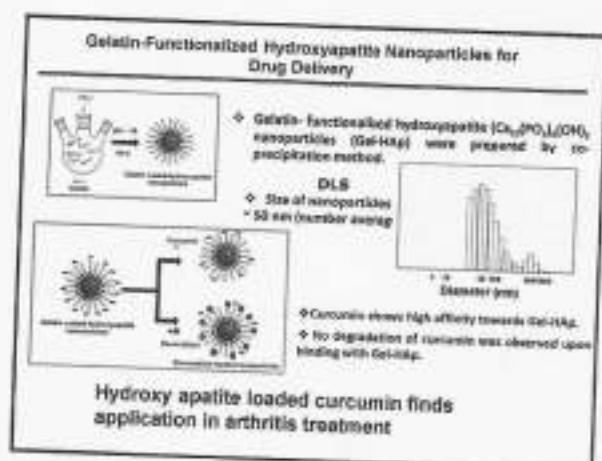
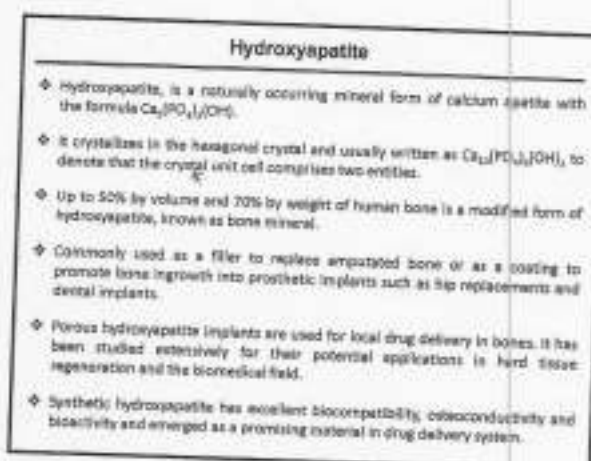
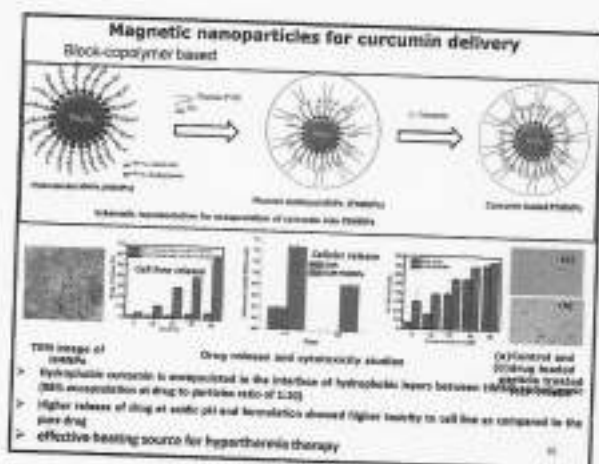
Introduction:

- Oral submucosal fibrosis (OSF) is a chronic, painless disease that is associated with significant functional morbidity and an increased risk for malignancy.

Advantages of OSF:

- The Gel-CUR sponges must be kept in the mouth without chewing and should be sucked slowly for better efficacy.
- It is made up of a special formula wherein the sponges slowly dissolve in the mouth releasing the ingredients.
- Our novel curcumin (CUR) sponges are made up of soft tissues and is rich in blood supply.
- Therefore, the ingredients absorbed from the sponges slowly directly enter the blood stream through an unusual alternative, bypassing gut metabolism and gives instant relief.





Future Directions

- Pilot plants for preparing turmeric extract (Preferably Super critical CO_2 extraction)
- Separate curcuminoid mix and curcumin from the extract, to prepare curcumin capsules.
- Separation of *turmerin* and *termeron* from turmeric extract/waste
- Large scale preparation of water-soluble, bio-available nano-curcumin formulations
- Develop functional foods with turmeric/curcumin
- Strict adherence to quality control & standardisations
- New research programmes on curcumin/turmeric
- Create nodal agencies for inter-institute comparisons

