Indian Institute of Technology Kharagpur 721302, India

Biographical Details

1. Name in full: **GOSWAMI TRIDIB KUMAR**
   (Surname followed by forenames)

2. Date of Birth: 4th MARCH, 1958

3. Nationality: INDIAN

4. Field of Specialization: FOOD PROCESSING AND PRESERVATION

5. Designation: **PROFESSOR**

6. Address
   (a) Official: PROFESSOR TRIDIB KUMAR GOSWAMI, AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT, IIT KHARAGPUR – 721302, INDIA

   (b) Residential: A – 118, IIT CAMPUS, KHARAGPUR - 721302, INDIA

   (c) Corresponding Address: Official √☐ Residential ☐

   Tel: 03222-283122 Fax: 03222-282244
   Mobile: **09647485515** E-mail: **tkg@agfe.iitkgp.ernet.in**

7. Academic career and professional attainments: The proposer is requested to furnish, under this head, all information regarding the nominee's degree and post graduate academic qualifications and distinctions.

(A)	Degree	Institution	Year
	Ph.D.	IIT KHARAGPUR	1987
	B.TECH.	JADAVPUR UNIVERSITY	1982
	B.Sc. (CHEM. HONS)	UNIVERSITY OF CALCUTTA	1978
	H.S.	WEST BENGAL BOARD OF SECONDARY EDUCATION	1974

(B)	Positions Held from Post Doc onwards till date	Institution	From	To
	PROFESSOR, HAG	IIT KHARAGPUR	2013	CONTINUING
	PROFESSOR	IIT KHARAGPUR	2007	2013
	ASSO. PROFESSOR	IIT KHARAGPUR	2002	2007
	ASST. PROFESSOR	IIT KHARAGPUR	1994	2002
	LECTURER	IIT KHARAGPUR	1989	1993
	TECHNICAL OFFICER, CRYOGENICS	KWALITY FROZEN FOODS PVT. LTD. (BOMBAY)	1988	1989

(C) Awards/ Special Attainments

- **Received "Bharat Gaurav" Award presented by International Friendship Society, India.**
- **Received "Innovative Teacing – Learning Practice" Award presented by Confederation of Education Excellence, New Delhi.**
- **Received BEST TEACHER award presented by Global Management Council, Ahmedabad.**
- **Received LIFE TIME ACHIEVEMENT Award presented by IJTA and Serials Publications Pvt. Ltd., New Delhi.**
- **Elected as a fellow of the Association for the Advancement of Biodiversity Science**
- **Received 3rd Technology Achievement Award for Excellence in Research presented by Research Branding Company, New Delhi.**
- **Received Distinguished Scientist award presented by Venus International Foundation, Chennai.**
- **Received certificate of appreciation from Department of Food Processing Industries and Horticulture, Govt. of West Bengal.**
- **Received best paper award in the International Conference on Advances in Chemical, Biological, & Environmental Engineering (ACBEE) held during 29-30 March, 2015 at Singapore.**
- **ELECTED AS NAAS FELLOW IN 2014.**
- **Elected as ISAE Fellow 2015.**
- **Elected as Institute of Engineers Fellow, 2016**
- Best paper was adjudged in 34th Annual Convention of ISAE, held at CCHAU, Hisar, India, Dec. 16-18, 1999.
- **Doctoral thesis under his supervision was awarded Jawaharlal Nehru Award offered by ICAR in July 2000.**
- Conferred with best poster presentation award in the 19th Indian Convention of Food Science and Technology on Health Foods held during 31st December 2007 to 2nd January 2008 at Indian Institue of Technology, Kharagpur.
- Conferred with best poster presentation award in the 42nd Indian Society of Agricultural Engineers Convention and symposium held during February 1-3 2008 at Central Institute of Agricultural Engineering, Bhopal.
- Conferred with best poster presentation award for the paper entitled "modeling of modified atmosphere packaging system for fruits using enzyme kinetics based respiration model" by S.Mangaraj and T.K.Goswami in the 44th Indian Society of Agricultural Engineers Convention and symposium held during January 28-30, 2010 at Indian Agricultural Research Institute, New Delhi.
- Conferred with best poster presentation award for the paper entitled "Fuzzy Logic modelling for sensory evaluation of MA packed fruits" by S.Mangaraj and T.K.Goswami in the National Seminar on "Food Security and Economic Prosperity through Processing & Preservation of Foods held during March 4th- 5th 2010, at Central Institute of Agricultural Engineering, Bhopal.
- **Doctoral thesis under his supervision was awarded Jawaharlal Nehru Award offered by ICAR in July 2010.**
- **N.N. Mohan Memorial Award for 2009 for best research paper conferred by All India Food Processors' Association, New Delhi – 16.**

- **Best Poster award was conferred at 1st International conference on innovation in food processing, value chain management, and food safety & workshop on food safety organized at NIFTEM during 10 – 12 January, 2013.**
- **Recipient of HONOURABLE MENTION (4th) in 2012 EDEM Academic Poster Contest (International) for the poster submitted on Modeling of material flow and particle breakage inside a cryogenic grinder.**
- **Doctoral thesis under his supervision was awarded Jawaharlal Nehru Award offered by ICAR in July 2014.**

(D) Intellectual property, technological innovations, new products including new varieties of plants and crops, copyrighted design and software etc. Licensed technologies, products, designs, software may be mentioned

Patents

- Goswami, T.K., Seth, N.K., and Kwality Frozen Foods Pvt. Ltd., Bombay. A device for maintaining heat labile frozen article in frozen condition. Indian Patent No. 169246, 3,8,1989.
- Goswami, T.K., Seth, N.K., and Kwality Frozen Foods Pvt. Ltd., Bombay. A device for self pressurising and discharging a refrigerant. Indian Patent No. 171572, 9.5. 1989.
- Goswami, T.K., Seth, N.K., and Kwality Frozen Foods Pvt. Ltd., Bombay. A device for pre-cooling and freezing or hardening of food materials. Indian Patent No. 169249, 3.8.1989.
- Goswami, T.K., Director, IIT, Kharagpur. A device for cryogenic grinding of spices, vegetables, food grains, plastic, and polymers. Indian Patent No. 192437, 12.10, 1998.
- Goswami, T.K., Director, IIT, Kharagpur. A device for cryogenically individually quick freezing of fish, marine products, meat, fruits and vegetables. Indian Patent No. 193658, 31.12. 1998.

(E) Other relevant information

➢ **Visit Abroad**

i. Presented a paper in the International Conference on Mechanical Engineering (ICME 2001) held at **Dhaka, Bangladesh**, during 26th to 28th December, 2001.
ii. Presented a paper at the Second International Conference on Information (INFORMATION 2002) held at **Beijing, China** during July 24 – 27, 2002.
iii. Presented at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting, held at **Portland, USA**, during 9-12 July, 2006.
iv. Presented at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting, held at **Reno, Nevada, USA**, during 21-14 June, 2009.
v. Presented an invited paper at the International Symposium on Fermentation, Source of Vitality at the Jeonju International Fermented Food Expo (IFFE) held at **Jeonbuk National University, Jeonju, Korea** on October 23 – 24, 2009.
vi. Presented at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting, held at **Pittsburgh, USA**, during 19-23 June, 2010.
vii. Presented at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting, held at **Dallas, USA**, during July 29 – August 1, 2012.
viii. Presented a paper in the IICBE conference held at **Dubai, UAE**, during 17-18 March, 2014.
ix. Presented a paper in the UREBE conference held at **Singapore**, during 29-30 March, 2015.
x. Presented at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting, held at **New Orleans, USA**, during 26 - 29 July, 2015.

➢ SPONSORED RESEARCH

Completed (as P.I.):

a. Studies on Cryogenic Grinding for Retention of Flavour and Medicinal Properties of Some Important Indian Spices, 2009-2013, NAIP, ICAR, **90.1** lakhs.
b. Rapid control atmosphere storage of foods. 2005–2007, Ministry of Food Processing Industries (MFPI), Govt. of India. Rs. **48** lakhs.
c. Development of an IQF tunnel freezer with liquid nitrogen. 1993-99, Technology Development Mission, Ministry of Science and Technology. (With Late Prof. S.P. Sengupta (Co-P.I.), Prof. G.C. Mazumder (Co-P.I.), Prof. A.B. Chattopadhyay (Advisor), and Prof. T.B. Ghosh (Co-P.I.). Rs. **70** lakhs).
d. Reduction of energy consumption and storage losses in cold storages for potato: survey and design improvements 1995-99, Indian Council of Agricultural Research. (With Prof. K. Chaudhury (Co-P.I.). Rs. **9.1** lakhs.)

Completed (as Co-P.I.):

a. Development of a programmable biofreezer using liquid nitrogen. 1991-94, Department of Biotechnology, Ministry of Science and Technology. (With Prof. Sunil Sarangi (P.I.), and Prof. M.K. Jana. Rs. **8.5** lakhs).
b. Cryopreservation of cells and tissues, 1990-1994, Council of Scientific and Industrial Research. (With Prof. M.K. Jana (P.I.) and Prof. Sunil Sarangi. Rs. **9.5** lakhs).

➢ CONSULTANCY

Completed:

a. Design and development of an IQF machine refrigerated with ammonia for peas, Aridhi Hi Tek, Bombay, alongwith Prof. H. Das (P.I.) and Prof. R.C. Arora. (Rs. 2 lakhs).
b. Evaluation of capacity of Rice Mill, Rice Millers' Association, alongwith Prof. S. Bal and others, 2 lakhs.
c. Trial Milling for Paddy, Food Corporation of India, along with Prof. S. Bal and others, Rs. 7.2 lakhs.
d. Evaluation of capacity of Rice Mill at Midnapur, Rice Millers' Association along with Prof. P.S. Rao, 0.005 lakhs.
e. Extended consultancy services for multi-purpose cold storage project for M/s Revati commercial pvt. Ltd., Kolkata.
f. Extended consultancy services to M/s Ganesh paramasivam, Baroda for Cryogenic Grinding.
g. Extended consultancy services to M/s Raj Entrepreneur, Ahmedabad for Cryogenic Grinding.
h. Extended consultancy services to Central Potato Research Institute Campus, Modipuram, Meerut, UP. for the development of a value chain Potato and Potato Products.
i. Extended consultancy services to Potato & Onion Merchants Association, Siliguri for developing an infrastructure for monitoring economical and geographical influence on Potato storage.

➢ PUBLICATIONS:

Publications	Number Completed	Number under Review
a. Publications in refereed journals	104	03
b. Publications in proceedings of seminars /	56	02

conferences		
c. Books & Monographs / Book Chapter	4 + 2 / 12	01

- **RESEARCH GUIDANCE:**

Levels	Number Completed	Number under Progress
a. Guidance at doctoral level	13	04
b. Guidance at masters level	77	05
c. Guidance at B. Tech. level	59	3

- **SHORT TERM COURSES ORGANIZED**:
  - Organized a short term training course (subsidized by SIDBI) on Skill cum Technology Upgradation Programme for Owners/Managers of Rice Mill and allied Industries during July 6 to July 18, 1998.
  - Organized a short term training course (partly self financed and partly subsidized by SIDBI) on Efficient Utilization of Potato Cold Storage during May 28 to June 1, 2001.
  - Organized a short term training course (partly self financed and partly subsidized by SIDBI) on Cold Storage of Potato during December 14 to 16, 2001.
  - Organized a short term training course (partly self financed and partly subsidized by SIDBI) on Potato Cold Storage during February 21 to 24, 2006.
  - Organized a short term training course (partly self financed and partly subsidized by QIP) on Potato Cold Storage during June 8 to 12, 2015.
  - Organized a short term training course (partly self financed and partly subsidized by TEQIP) on Cold Storage of Potato during July 13 to 17, 2015.
  - Organized a short term training course (partly self financed and partly subsidized by TEQIP) on Refrigeration, freezing & Cold Storage of food during September 12 to 15, 2016.
  - Organized a short term training course (partly self financed and partly subsidized by QIP) on Potato Cold Storage during February 27 to March 3, 2017.

- **Paper Setting**:
  - Agricultural University, Rajasthan.
  - Vidyasagar University, Midnapur, West Bengal
  - Agricultural University, Udaipur
  - Vignan University, Vadlamudi, Andha Pradesh
  - Agricultural Services Recruitment Board (ASRB)
  - Graduate Aptitude Test in Engineering (GATE)
  - NIFTEM, Sonpat, Haryana

- **Courses Designed**:
  - Member of the departmental committee for UG & PG course curricula, presently in vogue.
  - Introduced a UG (DD) / PG level course on Cooling Technology in Food Processing and Preservation

- **Member of the editorial board**:
  - Journal of Applied Sciences Research, (International)
  - Food Processing Technology
  - International Journal of Food Science and Nutrition; www.foodsciencejournal.com.
  - GLACIER, Journal of Scientific Research, Ahmedabad.
  - The open medicinal chemistry journal
  - Journal of Food and Industrial Microbiology.
  - International Journal of Agricultural and Biological Engineering (IJABE)
  - ADIT Journal of Engineering
  - American-Eurasian Network for Scientific Information
  - Cloud Journal
  - International Journal of Advanced Food Science and Technology
  - International Journal of Food, Agriculture & Veterinary Sciences
  - International Journal of Environmental & Agriculture Research
  - International Journal of Food Science and Nutrition
  - Journal of Food and Dairy Technology
  - Journal of Food Processing and Dairy Technology
  - Proficient International Refereed Journal of Science, Engineering and Technology
  - Proficient International Refereed Journal of Arts, Social Sciences & Education
  - Research Journal of Agriculture and Biological Sciences
  - The Challenge : An International Biannual Journal of Art, Culture, Language & Literature
  - The Standard International Journal (The SIJ)
  - Universal Journal of Food and Nutrition Science

- **Laboratory Development**:
  - Reorganized a portion of Dairy and Food Engineering Laboratory by incorporating 4 experiments in heat transfer analysis on food materials.
  - Set up a laboratory on characterization and preservation of food materials. Major equipments set up are :
    - Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyser (TGA), and Dynamic Mechanical Analyzer (DMA) for thermal analysis of food materials,
    - Control Atmosphere (CA) storage facility (Designed and built in-house).
    - Flavour analysis for mango fruit with the help of GC, GCMS, and HPLC.
    - Cryogrinding of spices.

- **Participation in National Academic Activities**

a. Member of a high level forum, organized by UNESCO New Delhi Office, on Strategies for Developing India's National Capabilities in Cryogenics Science and Promoting its Application in Agriculture, Medicine and Industry.

b. Member of Industry - Academic interaction programme organized by Department of Science and Technology (DST).
c. Acted as Co-chairman in food preservation session in etae-2004, an international seminar held at IIT Kharagpur
d. Acted as session organiser of food preservation session in etae-2004, an international seminar held at IIT Kharagpur.
e. Acted as Chairman in the Mechanized food processing session of the International conference on Food Security and Environmental Sustainability held during 17 – 19 December, 2009 at IIT Kharagpur.
f. Acted as Co-chairman in the food engineering session of 44th ISAE convention held during 28 – 29 January 2010 at IARI New Delhi.
g. Acted as Chairman in the food storage session of the National Seminar on "Sustainable Livelihood Development through Fruits and Vegetables Processing in North Eastern India" held during 8th and 9th March, 2010 at the Department of Agricultural Engineering under School of Technology in Assam University, Silchar.
h. Expert of IIT Bhubaneswar - Govt of Orissa Technology Development Programme.
i. Expert for review committee of IGNOU, Kolkata.
j. Expert of recruitment committee of Bidhan Chandra Krishi Vishaw Vidyalaya (BCKV), Kolkata.
k. Expert committee member of BOG of BCKV, Nadia, West Bengal.
l. Inaugurated the TEQIP – II sponsored National Seminar on "Recent Advances in Food and Fermentation Technology" RAFFT 2013 at Department of Food Technology, University Institute of Chemical Technology, North Maharashtra University, Jalgaon on 25th September, 2013.
m. Member of the selection committee for the post of faculty in Process Food Engineering of Uttarbanga Krishi Viswavidyalaya in 2014.
n. Expert member of National Horticulture Board (NHB), Govt. of India.

- **National program on technology enhanced learning (*telecasted by eklavya technology channel*):**
  - Transfer process in dairy and food engineering
  - Dairy and food products technology

- **Responsibilities undertaken at Institute / Departmental level**

a. Vice Chairman, Technology Aquatic Society, Technology Students Gymkhana ('03 – cont.).
b. Assistant Warden, JCB Hall of Residence ('04 – '07)
c. Warden, MS Hall of residence ('07 – '10.)
d. Member of the DAC (PGR) ('02 - '05, '08 – cont.).
e. Course Advisor of M.Tech. (DFE) ('02 - '05, '08 – cont.).
f. Member of DAC ('05 – '08)
g. Course Advisor of B.Tech. (1st Year) ('06 – '10)
h. Course Advisor of M. Tech. (FPE) ('08 – continuing)
i. Warden, Sir Ashutosh Mukherjee Hall of residence ('11 – '12)
j. Warden, BC Roy Hall of Residence ('13 – '16.)

- **Proficiency in computer:**
  - Proficient in Basic, Fortran, C languages, MS office, FLUENT (CFD) software

- **Member of Professional Institutions / Bodies:**
  a Life member of Association of food scientists and Technologists, AFST(I).
  b Life member of Indian Cryogenic Council (ICC).
  c Life member of Indian Institute of Chemical Engineers (IIChE).
  d. Member of the American Society of Agricultural and Biological Engineers (ASABE) since 2006.

- **Ph. D. Thesis (self):**
  - Studies on transportation of frozen fish with liquid nitrogen using dump charging method.

- **Ph.D. Thesis (guided):**
  - **Studies on cryogenic grinding of spices (Received JN Award, ICAR in 2000).**
  - Studies on controlled atmosphere storage for apple and litchi using liquid nitrogen.
  - Transgenic insect resistant rice lines expressing a novel cry1Ab type toxin gene of Bacillus thuringiensis.
  - CFD Modeling for heat and mass transfer on potato in cold store.
  - **Studies on rapid control atmosphere storage of mango (Received JN Award, ICAR in 2010)**.
  - **Modified Atmosphere Packaging of Apple (cv. Royal Delicious), Guava (cv. Baruipur) and Litchi (cv. Shahi) (Received JN Award, ICAR in 2014).**
  - Modified Atmospheric Packaging of Capsicum.
  - Comparative studies on ambient and cryogenic grinding of fenugreek and black pepper seeds. Identification of differentially expressed transcripts related to fibre formation in *Corchorus capsularis* using a lignified fibre-deficient mutant.
  - Identification of differentially expressed transcripts related to fibre formation in *Corchorus capsularis* using a lignified fibre-deficient mutant.
  - Comparative studies on ambient and cryogenic grinding of fenugreek and black pepper seeds.
  - Heat transfer modeling of black pepper seeds in cryogenic grinding system.

- **Ph.D. / M.Tech. (outside) Thesis (Examined)**
  - Examined M.Tech. thesis of IIT BHU in 2013.
  - Ph.D. thesis titled “Kinetic Studies on L-asparaginase Production, Purification, and Application of Dr. Yogendra Singh of IIT BHU was examined in 2013.
  - Examined Ph.D. thesis of Dr. Ravi Kumar Gundampati on “Production of RNAs enzymes…. Aspects of IIT BHU in 2013.
  - Ph.D. thesis titled “Studies in Supercritical Carbon di oxide Exteaction Technology for Development of Novel Food Supplements” of Dr. Dipan Chatterjee of Jadavpur University was examined in 2014.
  - Ph.D. thesis titled “Cryopreservation of Mesechymal stem cell and tissue engineered constructs using non-toxic cryoprotective agents” of Dr. Akalabya Bissoyi of NIT Rourkela was examined in 2014.
  - Ph.D. thesis titled “Microbial D-amino acid oxidase: Production, Purification, and Characterization, and its Biological Application” of Dr. Neeraj Kumar Gupta of IIT BHU was examined in 2014.
  - Evaluated Ph.D. thesis of a student of Jadavpur University.
  - Evaluated Ph.D. thesis of a student of Jain University, Bangalore.
  - Evaluated Ph.D. thesis of a student of Baptla University.

- ***Guest Lecture delivered**:*
  - Delivered an invited lecture on "Use of liquid nitrogen for individually Quick Freezing of Foods" in ICFoST '95 held at CFTRI Mysore during 7-9 September, 1995.
  - Delivered an invited lecture on "Cryogrinding of Spices" in Seminar cum Exhibition on Opportunities in the Agro Industry during 5-6 November, 1998 at Hotel Oberoi Grand, Calcutta, organized by Confederation of Indian Industry (CII) .
  - Small Industries Service Institute, Ministry of SSI, Kolkata had requested to deliver a lecture on "Indian Institute of Technology as a leading technology resource centre: the technologies developed for adoption by SSI units" in the Seminar on 'Technology Resourcing" on 28.05.03 at Indian Institute of Social Welfare & Business Management, College Square Kolkata.
  - Delivered an invited lecture on "Role of cryogenics in food processing and preservation" in the International Symposium on Fermentation, source of vitality at the Jeonju International Fermented Food Expo (IFFE) held during October 23 – 24, 2009 at Jeonbuk National Univrsity, Jeonju, Korea.
  - Delivered a lecture on "Controlled and Modified Atmosphere Storage of Fruits and Vegetables" at 44th ISAE convention held during 28 – 30 Janurary, 2010 at IARI campus, New Delhi.
  - Delivered a lecture on "MA and CA for storage of fruits and vegatables" in the National Seminar on "Sustainable Livelihood Development through Fruits and Vegetables Processing in North Eastern India" during 8th to 9th March, 2010 at the Department of Agricultural Engineering under School of Technology in Assam University, Silchar.
  - Delivered a lecture on "Modern Trend in refrigeration of Agriculture and Horticulture products & Marketing of Potato" in the Agri-Horti Marketing Conclave 2011during 25th to269th February, 2011, organized by Department of Agricultural Marketing, Government of West Bengal, and Indian Chamber of Commerce at the Park Hotel, kolkata.
  - Delivered a lecture on "Boons and Curses of Fermentation in Dairy Industries" at TEQIP – II sponsored National Seminar on "Recent Advances in Food and Fermentation Technology", RAFFT 2013, organized by University Institute of Chemical Technology, North Maharashtra University, Jalgaon on 25th September, 2013.
  - Delivered a lecture on "Food Safety" at the National Seminar on ""Safe Food for Healthy India – Challenges & Opportunity" organized by IQEMS at Hotel Mayfair Convention, Bhubaneswar during 21 - 22 February, 2014.
  - Delivered as a keynote speaker on "Can cryogenics be friendly to postharvest processing? in the National conference on Emerging Technology Trends in Agricultural Engineering" held at NERIST during November 07-09, 2014.

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8. A critical analysis highlighting the most innovative contributions of the nominee with respect to current knowledge in the field (If necessary, attach additional sheets).

Concepts:

- Based on the basic theory of heat transfer and physico-thermal properties of material, a concept was introduced for designing a frozen food transportation system (***Goswami** et al., 1987*).
- Based on the cryogenic technology, a concept on hardening of ice cream was introduced for the first time in India (*Indian Patent No. **169249,** paper cutting, letter of appreciation from KwalityFrozen Foods Pvt. Ltd., Bombay).*

- Based on the basic theory of heat transfer and physico-thermal properties of material, a concept was given for the design of a cryogenic grinding system. A cryogenic grinding system consisted of a precooler and a grinder. The precooler chills the material to be ground to a predetermined temperature wherein the volatile and nonvolatile components of the material to be ground is frozen which subsequently is fed to a cryogenic grinder. The grinder must be capable of handling low temperature otherwise the grinder may cease due to low temperature. The ground material is packed in a container which is sealable and kept for equilibration in terms of temperature. The size of the ground particles and the overall quality of the ground particles, spices in particular are much superior compared to that obtained under conventional grinding. (*Singh and* ***Goswami****, 1999, Citation 29*).
- Thermogravimetry measures the change in mass with time and temperature ranging from room temperature upto 600 ^{o}C. A new concept has been introduced wherein using thermogravimetry technique the proximate composition of food materials such as brown rice has been analysed (*Madhava and* ***Goswam****i, 2001, Citation 10*).
- Storage of potato in cold room is an age old method. Due to not attending the problems associated with the storage of potato in terms of quality losses due to rotting, cold injury and shrinkage of potato, a concept of in-depth analysis of the storage system with the help of computational fluid dynamics (CFD) was given to assist in proper designing a cold store. The fundamental problem of a cold storage is nonuniform distribution of temperature and humidity throughout the store. Some of the reasons are attributed to the fact that the bags of potatoes are over loaded in most of the cold storages and the mal-distribution of cold air in all parts of the storage. The position of the fans with respect to the bunker coils is another serious problem. With the help of CFD analysis at different loading conditions and different air flow rates distribution of temperatures in potatoes in the store can be predicted and thereby necessary measures can be suggested so that the loss of potato becomes as minimum as possible (*Chourasia and* ***Goswami****, 2006 a Citation17, b Citation 12, c, d, e, 2007 a Citation28, b Citation 10, c, 2008*).
- Computational fluid dynamics is a versatile tool by which, heat, mass, momentum, and species transport can be efficiently computed. The refrigeration load of a cold store is normally calculated at steady state and it is very difficult to estimate the unsteady refrigeration load. In the filed of potato cold store, it has been used extensively to estimate the transient refrigeration load of a cold store and loss of moisture (*Chourasia and* ***Goswami****, 2001Citation 13, 2004, 2007 Citation 12*).

Processes:

- Calcium has a strong affinity to form chellating compound. A process has been developed to impart structural strength of frozen apple (***Goswami*** *and Khaware*, *1998*).
- Design of an energy efficient model cold storage (***Goswami*** *and Chowdhury, 1999).*
- Detection of dilution of milk with the help of glass transition temperature by differential scanning calorimetry (DSC) (***Goswami*** *and Gupta, 2008*).
- Liquid nitrogen has the ability to cool rapidly and at the same time augment in changing the composition of the atmosphere. A process has been invented wherein both the advantages of liquid nitrogen has been utilized in preserving fruits such as litchi, mango through control atmosphere storage (*Mahajan and* ***Goswami****, 2002, 2004, 2007; Menon and* ***Goswami****, 2008*).
- Modified atmosphere packaging is method through which fruits and vegetables are stored / transported for shorter duration. Such a technology has been devised with the help plastics and polyethylene both under perforated and non perforated polymeric containers. (*Mangaraj and* ***Goswami*** *(2011), Pandey and* ***Goswami*** *(2012*).

Products :

- Liquid nitrogen operated programmable biofreezer (capacity 50 kg/h) _____ ***Goswami*** *and Sarangi, 1995; replication is in use at Cryogenic Engg. Centre, IIT Kharagpur.*
- Rapid control atmosphere storage system (capacity 10 kg) _____ *Singh and* ***Goswami****, 2006 Citation22; Mahajan and* ***Goswami****, 2004 Citation No. 36; 2001 Citation No. 35, Replication is in use at Agricultural and Food Engineering Deptt., IIT Kharagpur; Jadavpur University, Kolkata.*
- Technology of cryogenically freezing of fish (capacity: 50 kg/h) _____ ***Goswami****, 2001; Goswami, Ravindra and Nayak, 2001Citation 5, in use at Triveni Food Products Pvt. Ltd., Kolkata; Pasteur Engineering Kolkata.*
- A cryogenic grinding system for grinding 50 kg / h _____ *Singh and* ***Goswami****, 1999, Citation No. 29; 1999 Citation No. 14; 2000 Citation No. 10;* ***Goswami*** *and Singh, 2003 Citation No. 15; Kamani Centre, Jamshedpur is trying to commercialize.*
- Design of a cold storage with the help of CFD _____ *Chourasia and* ***Goswami****, 2009; 2007 Citation 28, 2006 Citation 17; 2001 Citation 13; in use with cold storages.*

Technologies :

- Effect of feed rate and temperature on grinding of cumin seed were developed for the case of grinding in a double disc, single rotating, attrition mill. Effects were determined for the dependent variables such as rise of temperature and size of the ground cumin, specific energy consumption and Bond's work index. The temperature was lowered with the help of liquid nitrogen. There was a gradual increase in temperature rise, and decrease in size of the ground cumin, but the specific energy consumption and work index were decreased first and then increased with increase in feed rate of cumin in the attrition mill. The effect of feed temperature of cumin at −100 °C gave quite low values of rise in temperature, specific energy consumption, work index and high value of reduction ratio compared to feed temperatures of cumin at 30 and −40 °C. The difference in said dependent variables was not of much significance between feed temperatures of cumin ground at 30 and −40 °C (***Goswami*** *and Singh, 2003, Citation No. 15*).
- Modified atmosphere packaging (MAP) is a gracious, cheap and convenient packaging system that has the capacity to preserve natural quality of food commodity in addition to extend the storage life, if it is used properly. MAP has been a proven technology to meet the consumer's demand for more natural and fresh foods, which is increasing day by day. This method is advantageous, as strict regulations are enforced on the use of other chemical preservation methods. It is also commercially successful for preserving certain fresh fruits and vegetables. MAP is a dynamic system where respiration of the packaged product and gas permeation through the packaging film takes place simultaneously. At equilibrium, the respiration rate of the commodity equals the permeation rate of the packaging film and it retains the desired atmosphere. The attainment of the equilibrium state depends on proper designing of MAP. This technique can be integrated with active or interactive packaging to improve the package atmosphere to achieve superior product quality and safety. Of late, the packaging films of required gas transmission properties are available. Also to achieve the desired film characteristics for MAP different plastic films are either laminated or co-extruded for its successful operation. Although an increasing choice of packaging materials is available to the MAP industry, most packs are still constructed from polyvinyl chloride, polyproylene, polyethylene and polyethylene terephthalate (*Mangaraj and* ***Goswami****, 2009, Citation No. 16*).
- Thin layer convective air drying studies were conducted in a laboratory model thin layer dryer designed and fabricated for this purpose. The variables selected were 70–150 °C drying air temperature, 0.5–2 m/s air velocity and 5–20 cm grain bed depth. Drying rate was limited by diffusion process due to the falling rate period in parboiled paddy. The effective moisture

diffusivity in convective air drying increased with increase in drying temperature. The moisture diffusivity varied widely with change in moisture content. The prediction models developed for the drying rate constant (power model and Arrhenius model) and Lewis model for moisture ratio fitted well to the data. For maximum head yield, minimum specific energy and minimum drying time, the optimum process parameters were grain bed depth 7–10 cm, air velocity 0.55–0.68 m/s and drying air temperature 112–116 °C. This combination gave 65–68% head yield and specific energy consumption 8.5–10.7 MJ/kg of water removed (*Rao, Bal, and **Goswami**, 2007, Citation No. 18*).

- The postharvest quality of litchi (*Litchi chinensis* Sonn.) cv. Bombay stored under controlled atmosphere (CA) at 3.5% $O_2$and 3.5% CO_2, 2C temperature and 92–95% relative humidity was studied. Fruits were also held in regular atmosphere (RA) maintained at 2C temperature and 92–95% relative humidity. Fruits kept at normal ambient conditions were used as controls. Various quality attributes measured revealed that fruits stored in CA exhibited Hunter "a" values of 11.2 after 56 days of storage, indicating the beneficial effect of CA on retaining the red color of litchi fruits. Fruits held in RA exhibited Hunter "a" values (7.9) lower than that of CA-stored litchi, showing that browning of litchi was noticeable in RA. Loss of weight was lowest (4.9%) for the fruits stored in CA compared to those stored in RA (11.0%) and control (33.1%). Loss of acidity and ascorbic acid content of fruits stored in CA were less than that of RA. The smallest increase of litchi firmness and pericarp puncture strength of 2.2 and 3.9 times of initial level, respectively, were observed even after 56 days of storage in CA. Total soluble solid of litchi increased from 19.3° Brix at harvest to 23.0° Brix until 48 days of storage in CA after which it declined to 22.8 °Brix. The sensory evaluation of aril color and taste showed that the fruits held in CA were rated good throughout 56 days of storage (*Mahajan and **Goswami**, 2004, Citation No. 36*).
- Liquid nitrogen has the capability of cooling as well as purging the gases present in a closed unit. Control atmosphere storage system is a good method for preserving fruits and vegetables. A technology has been introduced to use liquid nitrogen coupled with vapour compression refrigeration system for rapid cooling and establishing a desired composition in a CA chamber (*Mahajan and **Goswami**, 2001 Citation No. 35, 2007 Citation No. 5; Menon and **Goswami**, 2008 Citation No. 22, Bhande et al., 2008 Citation No. 46*).
- The underlying principle behind storage techniques like controlled atmosphere storage and modified atmosphere packaging involves manipulation of respiration rate of the stored produce. However, since respiration rate is dependent on factors like storage temperature, a mathematical approach to predict the respiration rate under given conditions would be an immense help in both design and process control of such storage systems. Validated mathematical models were developed to predict respiration rate of fruits and vegetables. (*Bhande, Ravindra, **Goswami**, 2008, Citation No. 46; Mahajan and **Goswami**, 2001, Citation No. 35*).
- In processing of tea leaves, Moisture sorption isotherms (EMC/ERH) of withered leaves, black and green tea are very much important to decide upon withering of tea. A technology was developed wherein EMC / ERH of both black and green tea can be predicted at different temperatures and different moisture contents. *(Ghodake, **Goswami**, and Chakraverty, 2007*, *citation No. 40; Ghodake, **Goswami** and Chakraverty, 2006, Citation No. 30*).
- Modified atmosphere packaging (MAP) of fresh produce relies on the modification of atmosphere inside the package achieved by the natural interplay between two processes: the respiration rates of the commodity and the permeability of the packaging films. MAP has been a proven technology to meet the consumer's demand for more natural and fresh foods, which is increasing day by day. Because of its dynamic phenomenon, respiration and permeation take place simultaneously, and it is necessary to design the MAP system and select the

matching films to achieve desired atmosphere early and maintain as long as possible. To meet the desired film characteristics for MAP, the different plastic films are either laminated or coextruded has been developed. (Mangaraj, **Goswami**, and Mahajan, 2009. Citation 36).

9. A brief statement, not exceeding 200 words, regarding the most innovative contribution of the nominee which, in the opinion of the Proposer, should be circulated to the Fellows. The impact of the contribution should be highlighted.

A. Research, design of cryogenic grinding of indian spices – retention of natural flavor, nutritional and medicinal properties: introduction of cryo-grinding machine into process industry.

B. Research, design, development of freezing technology - introduction of machine into the process industry:

- **i.** Tunnel-type IQF (*individual quick freezing*) machine (refrigerant: liquid nitrogen) for freezing exportable prawn
- **ii.** Programmable bio-freezer (refrigerant: liquid nitrogen) for cryo-preservation of cells, tissues, enzymes,
- **iii.** IQF machine (refrigerant: liquid ammonia) for peas.

C. Development of knowledge-based resource material for optimum design of cold storage: industry (some existing potato cold storages in the country) consulted the knowledge to modify infrastructure and operational parameters towards reduction of

- **(i)** cost of input energy
- **(ii)** moisture loss

D. Research and development of knowledge-based resource materials on identification of input parameters and their individual / collective effect (role) on the relevant output parameters in the following processes:

- **(i)** cryo-grinding of Indian spices (cumin, clove, black pepper, cinnamon, etc.)
- **(ii)** controlled atmosphere / modified atmosphere / low temperature (cryogenic) storage of fruits
- **(iii)** variable air-temperature potato-cold-store using computational fluid dynamics (CFD)
- **(iv)** heat transfer and moisture loss in commercial potato cold store – CFD modeling

10. Publications:

a. Research papers published in full

Publications in International Journals

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b. Publications in National Journals

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- **Editing a book –** *Food Process Engineering and Technology*, edited by Das, S.K., Datta, A.K., Goswami, T.K., and Rao, P.S. (2016), Excel India Publishers, India – ISBN – 978-93-86256-30-0.
- **Acted as *Guest Editor*** for Bentham Science on FOOD and PLANT BIOTECHNOLOGY : Thematic Issue, Volume 10, Issue 1.

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- **Reviewed book on** Food Process Engineering: Emerging Trends in Research and Their Applications, edited by Murlidhar Meghwal, PhD, and Megh R. Goyal, PhD, PE.

f. Other publications/reports

Recognition through National News Papers:

- The Sunday Observer – topic – “Kwality is the only national ….”.
- Ananda Bazar Patrika – topic - ” Alu Chase Khati Rukhte IIT r daoai”.
- Dainik Jagaran – topic – “Baignaniko ne kisano ko di paidabar barane ke sikh”.
- Dainik Jagaran – topic – “Alu krishoko ki bishes karyashala ayojit”.
- Hindusthan Times – topic – “IIT Camp for farmers”.
- Dainik Jagaran – topic – “Alu krishoko ki bishes karyashala ayojit”.

(Tridib Kumar Goswami)