ISSN 0000-0000
9 770000 000003

Quest ©

ज्ञानेन शीलम्

Vol. 3 No. 1

ARIBAS

January - 2015

Quest

Editors
Ruby Kharwar
Ravina Sewani
Shirley Dixit

Mentors
Dr. Dipika Patel

Technical Support
Mr. Sohil Patel

Editorial

The news describes the current situation well, but it may be overly optimistic. Unlike the semiconductor industry, where the optoelectronic revolution leading to computers and the Internet was guided by road maps based on quantitative understanding, here the understanding is guided only by qualitative pictures and words. The number of possible engineered viruses is almost unaccountably large, and the numbers that have been tried so far are only dozens. A magic virus with a high success rate even for gastrointestinal tumors almost surely exists, but it will probably not be found without a road map.

The prevalence of antimicrobial resistant bacterial pathogens has become a major public health concern. Extended-spectrum ß-lactamase (ESBL) production in the members of the family *Enterobacteriaceae* can confer resistance to extended spectrum cephalosporins such as azetronam and penicillins. Integrons are genetic structures capable of capturing and excising gene cassettes, which usually encode antimicrobial drug resistance determinants. The major cause of MDR is the plasmid mediated transfer of beta-lactamases between the species of *Enterobacteriaceae*.

If a person wishes to live on potato-based diet !!! then it's not a joke, it's possible. The facts regarding potatoes outlaws the myths associated with them. The article focuses on the importance of potatoes in wide variety of ways. The article emphasizes on the vital facts related to potatoes which help the human body in number of ways.

Stay tuned to 'QUEST' until the next installment get glued to this edition and dive in the pond of knowledge. We hope you enjoy reading the same as we enjoyed making it.

Editorial Office
Quest, ARIBAS,
New Vallabh Vidyanagar,
Vitthal Udyognagar - 388121,
Dist- Anand, Gujarat, India.
Phone: +91-2692-229189, 231894
Fax: +91-2692-229189
Email: editor@aribas.edu.in
Website: www.aribas.edu.in

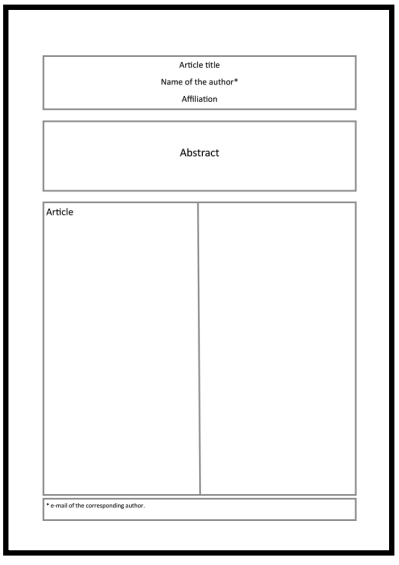
Published By
Director ARIBAS,
New Vallabh Vidyanagar,
Vitthal Udyognagar - 388121,
Dist- Anand, Gujarat, India.

Index

Notice to Authors

Manuscripts submitted to Quest should adhere to below mentioned criteria.
Research News: About 400 words (1 page)
Research Article: About 2000 words (4 pages)

Common for all: -
Font: Calibri
Font Size: 14
Columns: 2
Line Spacing: 1
Margin: Narrow
References: 1) In text citing, S No, Superscript.
2) Author's name (s), *Journal name*, **Volume No**, Page No**,** (year).
3) Maximum number of references should not exceed than 25.



Virus can kill cancer cells!

Canadian researchers launched the world's first clinical trial of a novel investigational therapy that uses a combination of two viruses to attack and kill cancer cells, and stimulate an anti-cancer immune response. This could have fewer side effects than conventional chemotherapy and radiation.

The therapy was jointly discovered and is being developed by Dr. David Stojdl (Children's Hospital of Eastern Ontario, University of Ottawa), Dr. Brian Lichty (McMaster University) and Dr. John Bell (The Ottawa Hospital, University of Ottawa), and their respective research teams and colleagues. The clinical trial, which is funded by the Ontario Institute for Cancer Research and coordinated by the NCIC Clinical Trials Group, is expected to enroll up to 79 patients at four hospitals across Canada. Up to 24 patients will receive one of the viruses and the rest will receive both, two weeks apart.

Christina Monker, 75, a former nurse from Rockland, Ontario, is one of the first patients treated in the trial. She was diagnosed with cancer in 2012 and, despite six weeks of radiation therapy and two rounds of chemotherapy, the cancer spread to both her lungs. After completing another 30 rounds of chemotherapy, she enrolled in the trial at The Ottawa Hospital and was treated on June 2, 2015.

"The nausea of chemotherapy was worse than I ever could have imagined, but with the viral therapy I just felt like I had the flu for a couple of days, and the symptoms were easily managed," said Ms. Monker. "It is too soon to know if I may have benefited from this therapy, but I'm very glad to contribute to this important research that could improve care for others."

Drs. Bell, Lichty and Stojdl began investigating viral therapies for cancer nearly 15 years ago when they worked together at The Ottawa Hospital.

"The cancer cells acquire genetic mutations that allow them to grow very quickly, but these same mutations also make them more susceptible to viruses." explained Dr. Bell.

The two viruses being tested in this clinical trial are called MG1MA3 and AdMA3. MG1MA3 is derived from a virus called Maraba, which was first isolated from Brazilian sandflies, while AdMA3 is derived from a common cold virus called Adenovirus. Both of these viruses have been engineered to stimulate an immune response against cancer cells that express a protein called MAGE-A3, but the Maraba virus also achieves an extra layer of anti-cancer activity by replicating inside many kinds of cancer cells and killing them directly. These viruses are manufactured in specialized facilities at The Ottawa Hospital and McMaster University.

"The idea behind this trial is to use the Adenovirus to prime the patient's immune system to recognize their cancer, and then use the Maraba virus to directly kill their cancer and
Viral therapies are one component of a growing field of cancer research that seeks to use biological materials (including cells, genes, antibodies and viruses) to attack cancer cells and further stimulate their immune system to prevent the cancer coming back," said Dr. Brian Lichty, associate professor at McMaster University.

stimulate an anti-cancer immune response. This field of research has been called biotherapy or immunotherapy. Dr. Bell and his colleagues recently launched the $60M BioCanRx network to advance this area of research.
"The NCIC Clinical Trials Group is very pleased to conduct this trial, which offers a potential new therapeutic approach for cancer patients that has been developed by Canadian researchers," said Dr. Janet Dancey, director, NCIC Clinical Trials Group and professor at Queen's University in Kingston.

The trial was approved by Health Canada, the Ontario Cancer Research Ethics Board and the BC Cancer Agency Research Ethics Board.

Source:

Ottawa Hospital Research Institute. Canada.

-Contributed by Aryana Singh M.Sc IGBT Sem-v.

Digital liver software

New technology with new idea of having electronic form of liver in our computer, is completed by virtual liver. The virtual liver a ready-to-use software simulation which mimics normal liver functions and generates likely outcomes of new drugs before the drug is tested on animals and humans.

Industry estimates suggest that nearly 50% of new drugs fail to pass through the clinical trial stage as the drugs are shown to have side effects, toxicity issues. Of that, 60% of the cases are related to liver injuries, due to flushing out toxins from the animals body, resulting in animal exploitation. This program will reduce animal killing as drug could be tested on electronic liver showing the different damages.

This extraordinary work is possibly done by Strand Life Sciences, founded by professors at the Indian Institute of Science (IISc) Bangalore; which has been awarded patent in US, can be used by pharmaceutical companies across the world to test new drug toxicity in the liver.

“We wanted to combine simulation along with experimental methods to predict toxicity. The simulation is made on a rat model and a human model can be decreased. Based on their outcomes, we know how a drug will react,” said Subramanimum.

The software is also been awarded patent to European region acknowledged by Kalyanasundaram Subramanian, chief scientific officer of Bangalore-based Strand Life Science.

Strand Life Sciences, founded in 2000 by a clutch of computer science and mathematics professors, it has captured a 30% share of the global genomic (the discipline related to genetics) market through its core business of selling software that allows research labs, academics, and pharmaceutical companies to do biological data mining and interpretation. The company generates over 90% of its business from global markets, and has revenues of about Rs 45 crore, with scientific software sales accounting for 50% of the revenues.

In 2007, Strand began work on the virtual liver and applied for patent rights in 2011. The vir-

tual liver allows the pharmaceutical industry to reduce the number, time, and expenditure associated with animal and human trials and able to understand the side effects of drugs on the liver.

With the patent being approved, the company expects business to increase and their labs to get busier. Strand has partnered with cosmetic companies to help them test their products on virtual software created for skin and hair.

Strand thinks of going more forward if they can do anything like virtual liver then they would like to look at the cardiac segment because that's another major area of toxicity.

Subramanian and his team has opened a new way of concluding the toxicity level of drug without any damage to living organism. If in same way virtual heart, stomach, brain development could be possible would lead to boost in pharmacological sector.

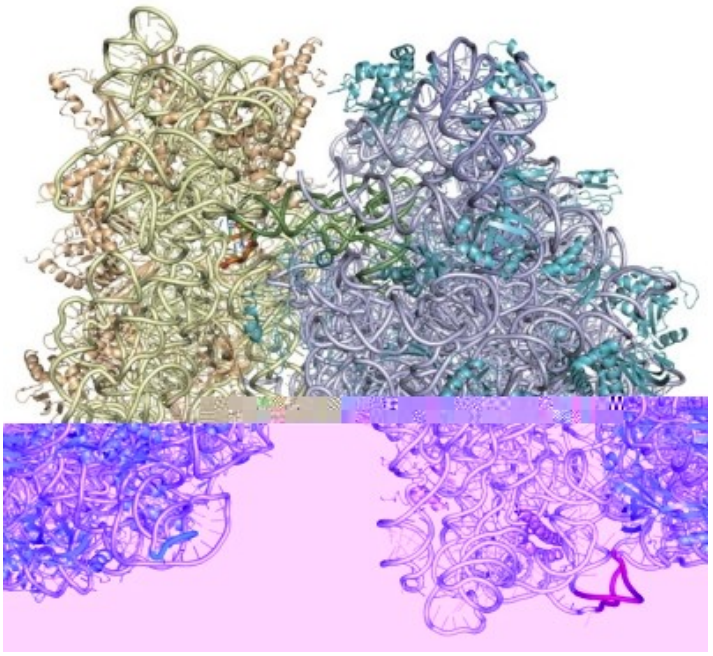
-Contributed by Lipi Sharma

M.Sc IGBT Sem-IX.

Designer Ribosome Works In Live Cells

Protein synthesis is the major task performed by living cells. For instance, roughly one third of the molecules in a typical bacterial cell are dedicated to this central task. Protein synthesis is a complex process involving many molecular machines. You can look at many of these molecules in the PDB, including DNA, DNA polymerases, and RNA polymerases; a host of repressors, DNA repair enzymes, topoisomerases, and histones; tRNA and acyl-tRNA synthetases; and molecular chaperones. Ribosomes are the cellular component that make proteins from all amino acids.

Ribosomes are made from complexes of RNAs and proteins. The number of ribosomes in a cell depends on the activity of the cell. Ribosomes are freely suspended in the cytoplasm or attached to the endoplasmic reticulum forming the rough endoplasmic reticulum. On an average in a mammalian cell there can be about 10 million ribosomes.



Polyadenylation is the addition of a poly(A) tail to a messenger RNA. The poly(A) tail consists of multiple adenosine monophosphates; in other words, it is a stretch of RNA that has only adenine bases. In eukaryotes, polyadenylation is part of the process that produces mature messenger RNA (mRNA) for translation.

Two polyadenine RNA tethers (red) link Ribo-T's two engineered ribosomal subunits, small (left) and large (right).

Ribosomes have two independent parts, small and large subunits, which come together in cells to form a complete structure when protein translation is needed. Small ribosomal subunits that make a specific protein have been prepared by genetic engineering before, but not the entire ribosome.

Researchers have artificially engineered a complete ribosome—the cell-based machine that translates mRNA into proteins—in the laboratory.

Mankin, Jewett, and coworkers designed artificial ribosome, Ribo-T by engineering ribosomal RNAs, the main components of the small and large subunits, into a single hybrid gene that included two short polyadenine RNA linkers to connect the RNAs. This modified gene was then introduced into bacteria. The bacterial cells transcribed the gene into tethered ribosomal RNAs, which then joined with ribosomal proteins made by the cells to form the complete ribosome.

Ribo-T can replace all of a bacterium's natural ribosomes, can express all native proteins in the bacterial genome, and works nearly half as fast as native ribosomes—fast enough to sustain normal cell growth and proliferation. The researchers also demonstrated that it could be engineered to make a protein with an amino acid sequence native ribosomes can't handle.

Scientists previously believed that, for ribosomes to work properly, their two subunits had to be independent and had to come together only when needed. But Ribo-T, with its linked subunits, seems to disprove that.

This Ribo-T can be used to explore poorly understood ribosome functions and make novel protein-based agents for drug discovery and other applications. Also, this ribosome can be used to endow ribosomes with new functions. For drug discovery and basic research, engineered ribosomes could create nonnatural proteins or even nonprotein polymers that would be difficult or impossible for native ribosomes to make.

Source: Chemical & Engineering News
ISSN 0009-2347

-Contributed by Ravina Sewani
M.Sc IGBT Sem-VII

MULTI-DRUG RESISTANCE IN *ENTEROBACTERIACEAE*

Devjani Banerjee*, Tejas Gohil, Himashu Toor and Yogita Patel

Ashok & Rita Patel Institute of Integrated Study & Research In Biotechnology and Allied Sciences (ARIBAS), New Vallabh Vidya Nagar, Gujarat. India – 388121.

Abstract: Multi Drug Resistance (MDR) in *Enterobacteriaceae* has been a major problem to the clinicians as in most of the cases the situation of the patient worsens because of the untreatable approach. Long-term treatment in hospitals especially in Intensive Care Units (ICUs), prolonged stay and use of high dosages of broad-spectrum antibiotics, make the patients increasingly susceptible to *Enterobacteriaceae* infection. Most concerning problem is how readily plasmid-mediated beta-lactamases are transferred between species of *Enterobacteriaceae* which is one of the major cause of MDR.

Introduction

Members of *Enterobacteriaceae* are gram negative rod-shaped, 1-5µm in length, non-sporing, non-acid fast, facultative anaerobes, fermenting sugars to lactic acid and various end products. Unlike similar bacteria, *Enterobacteriaceae* generally lack cytochrome C oxidase but exceptions (e.g. *Plesiomonas, Shigelloides).* Catalase reactions vary among the species of this family. Family includes motile bacteria except *Klebsiella* and *Shigella* and non-capsulated except *Klebsiella*.

It is the complex family of bacteria commonly present in large intestine of human and others are found in water or soil. Some are highly pathogenic. *Escherichia coli* is one of the most important model organisms, its genetics and biochemistry have been closely studied till date.

Sources

Most species of *Enterobacteriaceae* studied are from clinical sources. Clinical samples including UTIs, infected wounds, burn sepsis, blood, sputum and pus were screened mainly for the presence of these bacteria. Soil samples where the hospital wastages (medicines, edibles and patients' dressings) are dumped are the second important source of the *Enterobacteriaceae*. Animals are also the possible source of bacteria as animals are important carriage for transmission of MDR *Enterobacteriaceae*. Colonized or infected patients, devices, items, environmental surfaces contaminated with the body fluids in Long Term Care Facilities (LTCF) are important sources that increase mortality and morbidity.

Genome

E. coli genome has circular DNA molecule with 4.6 million base-pairs, containing 4288 annotated protein-coding genes (organized into 2584 operons), seven rRNA operons and 86 tRNA genes. Genome has significant number of transposable genetic elements, repeat elements, and bacteriophage remnants.

Comparison of genomic sequences shows a remarkable amount of diversity; only about 20% of each genome represents sequences present in every isolate, while 80% of each genome can vary among isolates. Thus very large variety of genes has been interpreted to mean that two-thirds of the *E. coli* pangenome originated in other species

** Corresponding Author: devjanichakraborty@aribas.edu.in*

and arrived through the process of horizontal gene transfer.

Another very recently discovered *E. Cloacae* complex, which includes the species *E. cloacae, E. asburiae, E. hormaechei, E*. *kobei*, *E. ludwigii* and *E. nimipressuralis.* The genome of *E. cloacae* consists of one circular chromosome of 4,734,438 base pairs and a mega plasmid, pEcWSU1_A, of 63Kb. The average G+C content of the genome is 54.5%. It has 83 tRNA genes and 8 rRNA operons each consisting of a 16S, 23S, and 5S rRNA gene. There are 4,632 protein-coding regions and 13 pseudogenes [1].

Under the selective pressure caused by antibiotics, bacteria with genes encoding resistance phenotype start secreting the enzyme in the natural environment. Carbapenems, the last line broad-spectrum antibiotics are the choice of the drug for the treatment but emergence of Carbapenemase producing *Enterobacteriaceae* (CRE) has lead to new challenges[2]. Tigecycline and the polymixins (polymixin B or colistin) are used to treat infections caused by CRE. Tigecycline is an FDA-approved drug used to treat complicated skin infections, intra -abdominal infections, and certain types of community-acquired pneumonia, but not used because poor serum levels are achieved. The polymixins are nephrotoxic, which limits their use. The challenge of confronting multidrug-resistant *Enterobacteriaceae* is not only of antibiotic resistance but also of definitions and identification. The ß-lactamases can be plasmid or chromosome mediated, can be induced or constitutively expressed and have different targets in the cell. It is common for MDR bacteria to carry more than one resistance mechanism in such cases labelling like 'CRE - Carbapenemase resistance *Enterobacteriaceae* or Klebsiella pneumonia Carbapenamase KPC - producing' become difficult and confusing [3].

The ability of laboratories to detect carbapenem resistance is limited, as many of the common screening methods have poor sensitivity to KPC producers. The modified Hodge test, an agar/antibiotic disk-based test, has been used as a confirmatory test with good sensitivity and specificity when compared with PCR testing.

Resistance Plasmid Families in Enterobacteriaceae

Most *Enterobacteriaceae isolates carries a large conjugative plasmid (pQC) containing genes encoding for heavy-metal resistance, mobile elements, pili- associated proteins and multiple-resistance genes.* Plasmid-mediated quinolone resistance (PMQR) has been reported by the acquisition of the *qnr*, *qepA*, and *aac (6')-Ib-cr* genes and associated with ESBLs and/or aminoglycoside resistance genes on the same plasmid. The IncFII, IncA/C, IncL/M, and IncI1 plasmids showed the highest occurrence among typed resistance plasmids in *Enterobacteriaceae* [4].

Typical Mechanisms of Antibiotics Resistance

a. **Inactivation of antibiotic by Enzymes secreted by Bacteria**

This is the major mechanism of antibiotic resistance either via hydrolysis or by modification happens in Antibiotics. Many antibiotics possess the hydrolytically susceptible groups which are responsible for biological activity. Bacterial enzymes covalently modify antibiotics leading to structural changes that impair target binding. Resistant pathogens inherit resistant genes on their plasmids.

- **Aminoglycosides** They are polycationic antibiotics which are inactivated by different aminoglycoside-modifying enzymes that reduce the net positive charges on them. Aminoglycosides, which are inactivated by enzymatic phosphorylation by aminoglycoside phosphoryltransferase (APH), acetylation by aminoglycoside acetyl transferase (AAC), or adenylation by aminoglycoside adenyl transferase or nucleotidy ltransferase.

- **β-lactamases** are hydrolytic amidases that cleave the β-lactam of penicillins and cephalosporins. More than 200 different β-lactamases have been identified and it is both chromosome and plasmid encoded. Extended spectrum β-lactamases mediate resistance to all penicillins, third generation cephalosporins and aztreonam have been observed majorly now a day[5]

b. Alteration of target protein

Enzymes involved in synthesis and assembly of peptidoglycan is the best target for the selective inhibition. The presence of mutation in the penicillin-binding domain of penicillin-binding protein (*PBP*) results in decrease affinity towards β-lactam antibiotics. For example in *S. aureus* resistance to methicillin and oxacillin is due to SSCmec element having *mecA* which codes for PBP2a, a new PBP that remains active to maintain cell wall synthesis in the presence of beta lactams [6].

c. Drug specific efflux pumps and outer membrane permeability

The efflux pumps are the membrane proteins that export the antibiotics out of the cell and keep its intra-cellular concentration low. Efflux pumps affect antibiotics classes like macrolides, tetracyclines, and fluoroquinolones because these antibiotics must be in the cell to exert their effect.

Efflux pumps vary in specificity and mechanism. This structure slows down drug penetration and is done by water–filled channels called porins. Changes in porins size, selectivity, and copy number alter the rate of diffusion of antibiotics [7].

Bacterial resistance can be intrinsic or it can be acquired. Bacteria acquire antibiotic resistance as a result of spontaneous chromosomal mutations or by acquiring plasmid-born resistance alleles by horizontal gene transfer. A variety of genes can be involved in antibiotic resistance because there are several targets or biological pathways for the antibiotic. Studies of bacterial pathogens have been identified the numerous loci associated with the resistance. Mutation also leads to modifications of gene expression of the efflux system. Reduced expression or absence of the OprD porin of *P. aeruginosa* reduces the permeability of the cell wall to carbapenems.

Horizontal gene transfer

It is the principal mechanism of the spread of resistance via conjugation, transformation and transduction. Resistance genes can be further incorporated into the recipient chromosome by recombination. Among Gram-negative anaerobes and Gram-positive bacteria, conjugative transposons are important mediators of genetic exchange with large R-plasmids of enteric bacteria. These large elements are capable of self-transfer to a wide variety of species. Conjugative transposons in the *Bacterioides* referred to as Tc-elements having tetracyvcline resistance genes (tetQ) responsible for more than 80% tetracycline

resistance among *Bacteroides* clinical isolates[8]. Horizontal transfer of multiple resistance genes in clusters to the recipient is enabled by specific DNA structures called integrons [9]. It is present on chromosomes or on broad host range plasmids. Gene cassettes are the smallest mobile genetic entities that can carry resistance determinants. Integron movement allows transfer of the cassette-associated resistance genes from one DNA replicon to another when integron is incorporated into a broad host range plasmid. A plasmid with a resistance gene cassette acquire additional resistance gene cassettes from donor plasmids and encodes many types of resistance including to chloramphenicol, beta- lactams, aminoglycosides and quinolones. Over 40 gene cassettes and three distinct classes of integrons have been identified to date [10].

Adaptive mutagenesis

Most mutations occur as the error during the DNA replication process in dividing bacteria but experimental data shown mutation also arise in non-diving cells. Adaptive mutations arise only in the presence of non-lethal selective pressure that favours them in natural conditions. Some antibiotics are able to induce the SOS mutagenic response and increase the rate of emergence of resistance in *E.coli* [11]. Several model systems have demonstrated that stress enhanced bacterial mutagenesis is a regulated phenomenon. The main factors in this process are stress (regulated SOS response) error-prone DNA polymerases V and IV, which increase the rate of mutation.

Spontaneous mutations

These mutations occur randomly as replication errors or an incorrect repair of a damaged DNA in actively diving cells.

They are called growth dependent mutations in the absence of any selective pressure, thus differing from adaptive mutation [12]. Antibiotic resistance occurs by nucleotide point mutations and able to produce a resistance phenotype. Quinolone, resistance phenotype in *E.coli* is a result of changes in at least seven positions in the *gyrA* gene, but in only three positions in the *par*C gene [13]. A variety of genes can be involved in antibiotic resistance because mutations in the genes encoding the target of certain antibiotics. Some of the resistances associated with the uptake and efflux systems are caused by mutations in regulatory genes or their promoter regions. The overproduction of antibiotic-inactivating enzymes may also be achieved through mutational events. Many Gram-negative microorganisms produce chromosomal β-lactamases at low levels and mutations producing up-regulation of their expression may lead to the resistance to most cephalosporins.

Hypermutators: Low spontaneous mutation rates are maintained by the activity of many molecular mechanisms that protect and repair DNA, as well as by the mechanisms that assure high-fidelity of DNA replication ([(14)]. However, bacteria with an elevated mutation rate (hypermutable strains or mutators) among natural and laboratory populations have been found. Frequency of mutators observed among natural and clinical bacterial isolates is much higher among natural and clinical bacterial isolates is much higher than expected, which suggests that there are situations in nature where being a mutator confers a selective advantage.

According to the currently most acceptable '*hypermutable state*' model, during a pro-

Longed non-lethal antibiotic treatment, due to selective pressure a small bacterial population enters a transient state of a high mutation rate. If a cell in this hypermutable state achieves a useful mutation, thus relieving the selective pressure, the cell begins to grow and reproduce, and at the same time exits the hypermutable state. The results of various studies have shown that mutators play an important role in the evolution of antibiotic resistance [15].

References

1. Jodi L, Humann W, Chun-Huai C, Taein L, Jane E, Jennifer C, Doreen M, Brenda K, *Standards in Genomic Sciences*, **5**, 279-286, (2011).
2. Ryan SA, Kerri AT, Sharma S, Phillips M, Kristie J, Morgan DJ, *South Medicine Journal*, **104**, 40-45, (2011).
3. Edwin C, Kristin MS, Paula MS, Jane H, Ruth L, Clinical and Health affairs, (2011).
4. Carattoli A, Resistance Plasmid Families in *Enterobacteriaceae, Antimicrobial Agents and Chemotherapy*, **53**, 2227-2238, (2009).
5. Nikaido H, Zgurskaya H, *Current Opinion Infectectious Diseases*, **12(6),** 529-36, (1999).
6. Cosimo F, Maxim S, Sergei V, Shahriar M, *The Journal of Biological Chemistry*, **279**, 40802–40806, (2004).
7. Senka D, Jagoda, Blaenka K, Biochemical and Genetic Aspects, Antibiotic Resistance in Bacteria, Food Technology Biotechnology**, 46(1)**, 11–21, (2008).
8. Salyers, AA, BS Speer, NB Shoemaker, *Molecular Microbiology*, **4**,151- 156, (1990).
9. Ploy M, Lambert T, Couty J, Denis F, *Clinical Chemistry and Laboratory Medicine*, **38**, 483–487,(2000).
10. Boucher Y, Labbate M, Koenig JE, Stokes HW, *Trends Microbiology***, 15**, 301, (2007).
11. Piddock L, Griggs D, Hall M, Jin Y, *Antimicrobial agents and Chemotherapy*, **37**, 662 -666, (1993).
12. Krasovec R, Jerman I, *Medical Hypotheses,* **60**, 484–488, (2003).
13. Hooper D, Drug Resistance, Update **2**, 38–55, (1999).
14. Schaaper RM, Base selection, *The Journal of Biological Chemistry,* **268**, 23762-23765, (1993).
15. Chopra I, AJ O'Neill, Miller K, Drug Resistance. Update, **6**, 137-145 (2003).

Myths and Facts about Impending Potatoes: A Review

Anamika Jha* Nisha Daxini

Ashok and Rita Patel Institute of integrated Study and Research in Biotechnology and Allied Sciences(ARIBAS), New Vallabh Vidyanagar, Anand- 388121 (Gujarat), INDIA

Abstract: European farmers could survive in the nineteenth century on potato-based food only as they had nothing else to eat. Certainly it was the potato that helped to keep Germany alive during the two world wars, as the potato tubers are safe underground and could not be destroyed by burning like standing crops of other food plants. A new compound called Kukoamine extracted from potato helps in lowering 4-5 % of blood pressure. Potato consumption has also been associated with augmenting the growth of gut microflora and such informations have equipped the researchers with useful tools such as metabolomics. Metabolomics is the science of the diversity of the small molecules produced by microorganism in relation to genomic information and to other properties of interest such as nutrition and disease. This article focuses on the myths and facts associated with potato usage.

Introduction

What makes potato so important in our lives? The answer underlies in the fact that potato is an underground storehouse of complex carbohydrates and a highly versatile vegetable that is also fiber-rich, supplies some protein and substantial amount of vitamins and minerals, is satisfying in winter meals and reasonably priced and next to no fat. Potato is the world's most widely consumed vegetable in variety of forms. Different varieties of potato with a range of beautiful colors and shapes are grown in the fields. These varieties can be differentiated by age, shape, color, and starch content and the time taken to reach maturity.

Solanum tuberosum commonly known as potato or Irish potato belongs to the family Solanaceae and came from the high lands of Peru and Bolivia[1]. Its use began to spread during the eighteenth century, although a violent opposition could be witnessed from some parts of Europe because of its relationship to the poisonous nightshade family, *Solanaceae*. However, in the later half of the eighteenth century, it had achieved greater recognition as a crop of great commercial importance[1]. On global level, Europe is the largest producer (> 70%) of potato followed by Soviet Union, Poland and Germany. North America and South America are placed below them. In Asia the major producers in order of importance are China, India, Japan, Turkey and Korea. In India, the major potato producing states are: Uttaranchal, West Bengal, Bihar, Punjab, Madhya Pradesh**,** and Tamil Nadu.

Myths associated with potato usage

It seems somewhat paradoxical that, in a developing country like India where the population continues to grow and the demand for food is increasing day by day, the potato has not yet been recognized as a food crop due to various myths associated with the potato usage. People think that potato is a storehouse of starch only, has no other nutrient element, its consumption leads to obesity and the persons suffering from diabetes and heart diseases should avoid its intake. Despite their nutritional and medicinal value 50-60% of

** Corresponding Author: anamikajha@aribas.edu.in*

consumers are advised by their doctors not to eat potatoes during illness[2].

Though people usually think of starch when they think of potatoes, they don't often think of vitamin C. Yet this humble tuber is a good source of vitamin C, with 26 mg or 44% of the Recommended Daily Allowance (RDA) in one potato. Because of the quantity people typically eat (i.e. far more than any other vegetable), potatoes are actually a leading source of vitamin C in the diet. So, one more reason we don't need oranges for a nutritionally complete diet[2].

Composition

Chemical composition is the main factor influencing the consumable value of potatoes. The nutritional value is determined by the total content of nutritionally important substances and their usability in food. The energetic contribution of potato is lower. Judging by their alimentary properties, potatoes are close to vegetables. The raw tuber contains 70-80% water, 10-30% carbohydrates (mainly starch but also a little sugar), 1-3% proteins, 2-3% fibers and 0.1% fats (Figure 1). One potato supplies 4 grams of protein, 30-40% of the RDA for vitamin B6, over 800 mg Potassium, 2 mg iron, 4 mg of Niacin (25% of the RDA) and 54 mg of magnesium (18% of the RDA). Because of the high content of minerals, especially potassium, potatoes belong to alkaline foodstuffs and contribute to counterbalancing meals of an acidic nature.

In potato tubers, sugars are present in the form of sucrose, glucose and fructose. The average sugar content is 0.46 - 1.72% of the total tuber weight, but can be increased to 5 % and more under inappropriate storage conditions such as refrigeration converts the starch to sugars creating a sweet potato.

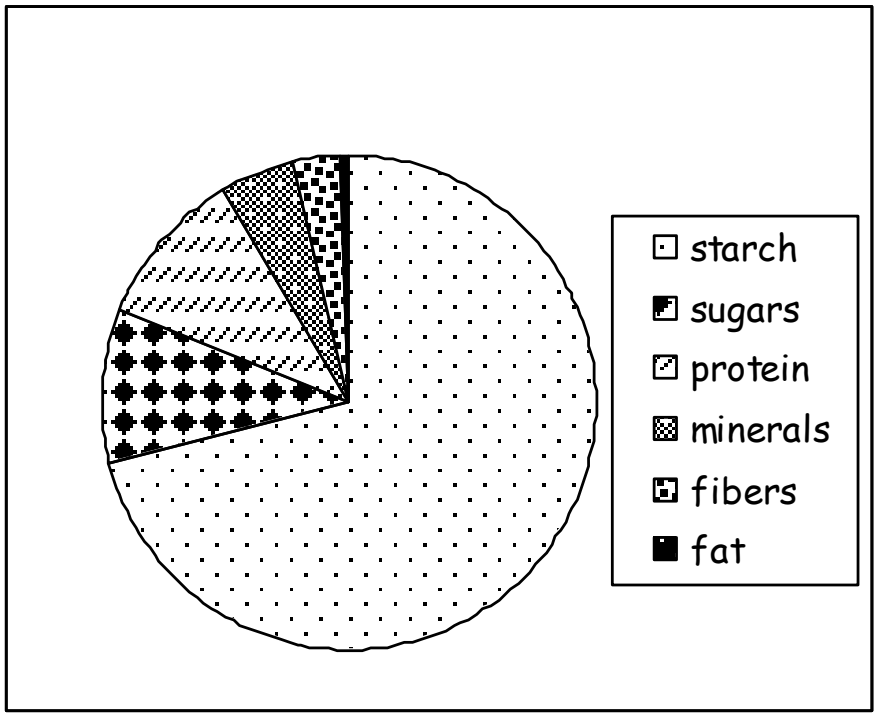


Figure 1. Chemical composition of potato (excluding water).

Benefits of potato consumption

The greater part of the proteins, minerals, tannins, crystals and pigments (in colored varieties) is localized in the outer layers of the cortex. Deep peeling of potatoes should always be avoided since it removes the valuable nutritional ingredients. Potato now occupies a prominent position in the world's food economy. Potatoes are consumed in a great variety of ways such as boiled, steamed, fried, baked or roasted. They are also processed into many products such as potato chips or crisps, dehydrated mashed potatoes, potato flour, frozen French fries and canned potatoes. Boiled or baked potato has low calorific value that is far less than French fries and potato chips and therefore, can be consumed by the people feeling conscious for their weight. But this is an interesting fact that French fries have very less calorific value when compared with other famous and popular diets such as bread, corn flakes, chocolates, cashew nut and biscuits.

Protein content of potato

Potato protein contains sufficient amounts of all essential amino acids in optimum ratio and therefore its biological value is high as it can be compared with animal proteins. When potato is mixed with egg the biological value becomes higher than the biological value of egg taken alone (Figure 2). This becomes important due to higher lysine content in comparison to other cereals. Nitrogen content of potato is comparable to the nitrogen content of milk and little less than that of egg. Potato protein is of very high quality and is good for the growth and development of persons of all age groups.

Vitamins

100 g fresh potato contains 20-30 mg of Vitamin C. It's amazing to know that potato is the main source of obtaining Vitamin C in America. The contribution of potato as a source of Vitamin C is 20% in contrast to 18% by other citrus fruits. Vitamin C helps to remove toxic substances from an organism produced by the biological metabolism and is an important factor in bone development. Unfortunately, this vitamin is rather unstable and is quickly destroyed during potato treatment. In countries like India where fruit and vegetable consumption is low, potato can prove main source of Vitamin C. Potato is also a good source of Thiamine, Niacin, Pyridoxine and Vitamin B_6. It also contains Vitamin B5, Riboflavin and Folic acid. Generally, 100 g of freshly harvested potato contains 0.1 mg Thiamine, 1.2 mg Niacin, 0.25 mg pyridoxine, 0.3 mg Pantothenic acid, 0.01 mg Riboflavin and 14 mg Folic acid.

Minerals

Potato is the main source of phosphorus. Due to the lower phytic acid content of potato, a larger part of phosphorus becomes available which further helps in making Ca, Fe and Zn available to the body in sufficient quantities. 100g of fresh potatoes contain 247 mg potassium in contrast to only 11 mg of sodium. Non-haem iron of potato and other vegetables is easily absorbed in presence of Ascorbic acid. Magnesium is another very important mineral. 100g fresh potatoes contain approximately 21 mg of Mg. Little amounts of micronutrients such as Zn, Cu, Mn, Mo and Cr can be obtained from potato. Besides this, potato also contains B, Br, I, Al, Co and Se in small quantities.

An investigation on the effect of fat free potato

Miller *et al*.[3] investigated the effect of fat-free

potato chips made with olestra compared with regular potato chips on fat and energy intakes. Ninety-five participants (unrestrained and restrained males and females) were tested in two conditions. In the information condition, participants were given nutrition information about the chips and were aware that the chips differed in fat and energy contents. In the non-informative condition, participants were not aware of the differences. In both conditions, participants ate either regular or fat-free potato chips ad libitum for an afternoon snack. The results showed that all groups significantly reduced their fat and energy intakes in the snack when eating the fat-free chips compared with the regular chips. Over 24 h all participants had lower fat intakes when eating the fat-free potato chips compared with the regular chips, but 24 h energy intake was not significantly different between groups. When information was provided, restrained participants ate more of the fat- free chips than the regular chips; however, this increase did not negate the reductions in fat and energy associated with eating the fat- free chips. This study revealed that substituting fat-free potato chips for regular-fat chips can help reduce fat and energy intakes in short-term (within meal) situations and reduce fat intake over 24 hour.

A Heart-Healthy, Antioxidant-Rich Comfort Food

potatoes contain a variety of antioxidants (carotenoids, vitamin C, vitamin E, glutathione, and flavonoids) which have protective role in the lung cancer risk. A study involving 541 cases of lung cancer and 540 hospitalized controls was carried out in Uruguay. With the exception of lycopene and vitamin C, the remaining antioxidants were associated with significant reductions in risk of lung cancer. Of particular interest was the inverse association between dietary glutathione and lung cancer. It can be concluded that dietary antioxidants

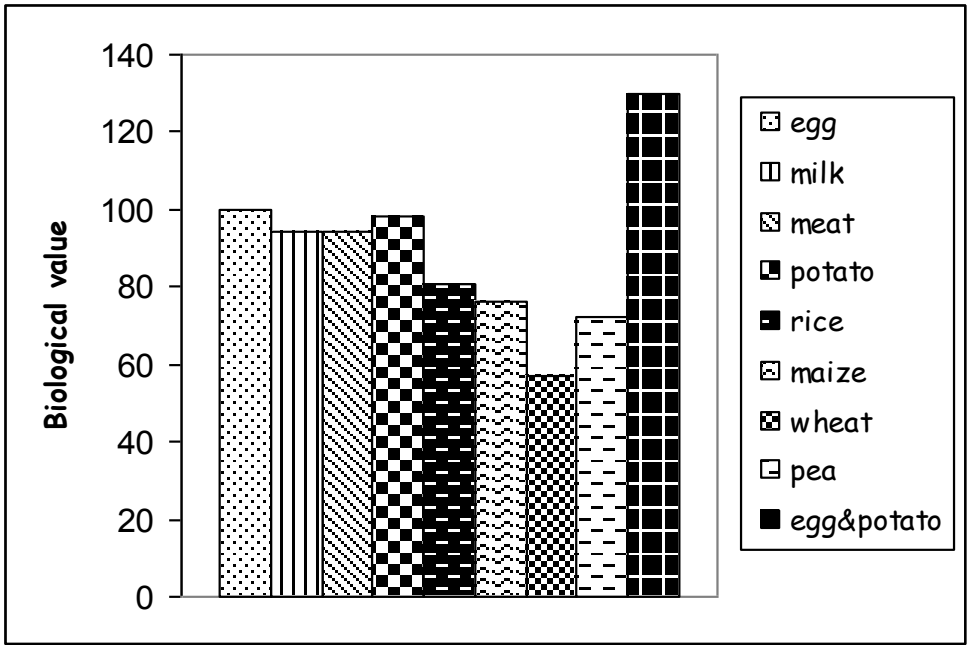


Figure 2. Biological value of potato is higher than other foods.

are associated with a significant protective effect in lung carcinogenesis[4]. The powerful antioxidant, glutathione is also known to exercise enthusiasts and bodybuilders.

Potatoes can lower the blood pressure

t has also been discovered that potatoes contain newly identified compounds that lower blood pressure called "kukoamines." The compounds, discovered by UK scientists at the Institute for Food Research (IFR), were previously only thought to exist in *Lycium chinense,* an exotic herbal plant.

Colorful potatoes pack more nutrients

Potatoes are not only tasty, but they are also a good source of nutrients. Now, studies are being conducted to examine additional health benefits of dark-pigmented varieties not often found in the United States. That's because brightly colored orange, red and purple potatoes might one day provide health-promoting properties beyond those found in ubiquitous white- and cream-colored spuds.

So far, the primary benefit likely to be derived from boldly colored potatoes seems to be heightspuds such as these can be commercialized.

Drawbacks

Several reasons have been found to be associated with the diminishing popularity of potatoes in Germany and other parts of the globe in recent years. Few reasons have been discussed below:

Potatoes dreadful as sugar

At the heart of the argument against potatoes is their high level of carbohydrates. White potatoes are like white sugar and white bread, not only do they cause a spike in blood sugar, but also they can raise levels of harmful triglycerides and lower HDL (good) cholesterol. This increases the risk of heart attack, particularly in people with insulin resistance. Two Harvard studies also found that eating a lot of potatoes increases the risk of developing type II diabetes. Further, while most vegetables reduce the risk of cancer, potatoes do not appear to have this effect.

Mode of Potato consumption

Eating a plain baked potato is one thing. It is in this form, or, perhaps, roasted, mashed, boiled or steamed, that a case for a healthy potato can be made. When potatoes come in their processed form like French fries, potatoes chips, tater tots, hash brown patties then no one claims that they are good for you. But it is in this processed form that the majority of potatoes are consumed.

What is so unhealthy about fried potato chips and French fries?

- They contain artery-clogging trans fats.
- They contain acrylamide, a cancer-causing

substance. While the EPA safe limit for acrylamide in drinking water is 0.5 parts per billion (ppb), a small order of fries contains 400 ppb.

They are cooked in vegetables oils that may be rancid, thereby producing large amounts of free radicals in the body. The potato is in the news again, this time more specifically the "French fry" because of the compound "Acrylamide" that is formed when the potato or other carbohydrate rich foods are deep fried, or cooked at high temperatures.

Glycoalkaloid of potato

Potato tubers contain a glycoalkaloid called solanin.100g fresh potato contains 5 mg solanin. When this concentration exceeds to 20 mg then such potatoes are not suitable for eating[5]. The taste of potato becomes bitter when amount of solanin becomes higher than 10 mg in 100 g fresh potato.

Genetic engineering of potato for improved traits

One of the goals of plant genetic engineering has been to create crops that are tailored to provide better nutrition for humans and their domestic animals. Though the enhancement of desired traits has traditionally been undertaken through conventional plant breeding since time immemorial but Genetic engineering has created plants with the desired trait very rapidly and with great accuracy. Potato (*Solanum tuberosum*) has one of the richest genetic resources of any cultivated plant[6]. Most wild species can be crossed directly with the common potato and, are therefore, useful for the enrichment of cultivars. These plants possess a broad spectrum of resistances to pests and diseases, tolerances to frost and drought and many other valuable traits. On the whole, with the exception of possible allerogenicity, scientists believe that GM (genetically modified) foods do not present a risk to human health. There is no unequivocal evidence that genetically modified crops harm our health or the environment - yet there is an intense debate about their value and safety[7].

Conclusion

Potatoes have been eaten for centuries with no significant evidence of harm. Objections peaked few years ago. The market research and focus groups have shown that most people aren't aware of the nutritional value of potatoes. The biggest thing one can say is that potatoes are an economical source of nutrients. People should be cautioned against preparing and dressing potatoes in ways that does not transform them into health demolisher. Throughout the controversy, potatoes have retained faith of several million people and continue to be one of the favourite and complete diets, but certain disadvantages associated with the tuber can be overcome with the help of emerging genetic engineering tools.

References

1. Kochhar SL, In: *Economic botany in the tropics*, (Ed. SL Kochhar.), McMillan publishers India limited, New Delhi. 72 (1986).
2. Proceedings of the international scientific conference on the occasion of the 55th anniversary of the Slovak agricultural university in Nitra Acta fytotechnica et zootechnica, Special number, **4 ,** (2001).
3. Miller DL, Castellanos VH, Shide DJ, Peters JC and Rolls BJ, Effect of fat-free potato chips with and without nutrition labels on

fat and energy intakes. *American Journal of Clinical Nutrition*, **68**: 282-290, **(**1998)

4.Stefani ED, Boffetta P, Deneo-Pellegrini H, Mendilaharsu M, Carzoglio JC, Ronco A, Olivera L, Dietary Antioxidants and Lung Cancer Risk: A Case-Control Study in Uruguay, *Journal of Nutrition and Cancer*, **34 (1)**, 100-110, (1999)

5. Pusztai, A, *Chemistry Industry,* The need for rigorous risk assessment. **8**, 280, (2000).

6. Paroda, RS, *Potato research and development in India,* Keynote address, Global conference on potato, Indian Potato Association, (1999).

7. Jha A, Jha S and Gautam HK, The GM Potato Issue: A Health Concern, *International Journal of Agriculture, Environment and Biotechnology,* **4(3)**, 213-219, (2011)


"We
are committed to nation
through our quality teaching
and research keeping students in
focus along with involvement of
our employees and continual
improvement in all areas."
ज्ञानेन शीलम्
ARIBAS
A CVM Institute

ज्ञानेन शीलम्

Do send us your comments and suggestion at e-mail:

quest@aribas.edu.in

ASHOK & RITA PATEL INSTITUTE OF INTEGRATED STUDY & RESEARCH IN BIOTECHNOLOGY AND ALLIED SCIENCES

P.O. Box No. 61, New Vallabh Vidyanagar, Vitthal Udyognagar - 388121, Dist- Anand, Gujarat, India.

Phone: +91-2692-229189, 231894 Fax: +912692-229189