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## An emerge need of artificial meat, ensure public health and animal welfare: A review

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### Abstract

The present study aims to evaluate the need for artificial meat to ensure public well-being. The literature was taken from scientific published peer-reviewed studies from the databases i.e., Google Scholar, PubMed using keywords, meat culture, artificial meat production, artificial meat, etc. It was found from the literature that meat consumption has been becoming a key to fulfill the protein requirement of the human body. Whereas, slaughtering animals, may lead impact on the environment and amplify chances of contamination and loss of quality characteristics therefore the present study is designed to aware public about the under-controlled and well-monitored method of meat production at laboratories by hygienic condition with necessary nutritional characteristics, a rapid and good mean of energy. Carry out such review studies could be helpful for the population to reduce the risk of pollutions, contamination, loss in quality as well as quantity, and diseases in rising nations including Pakistan.

**Keywords:** Meat, meat culture, public health, animal welfare

### Introduction

Meat, an affluent mean of animal protein, ironic in animal fat, so presenting substitute energy stream to carbohydrates (Arkadiusz. 2015) [2]. Nearly 2/3rd Agri-land is for livestock rearing, while the rest of the 1/3rd only just meets mankind's plant-based food need (Welin and van der Wende 2012) [40, 41]. Furthermore, meat production (MP) is intensifying with the economic pressure that results in environmental devastation and extraordinary contamination, connected to huge plant depletion and greenhouse gases (GHG) discharges. Presently, its production is among 15 & 24% of total current GHG releases, greater to overall emission from the transportation sector & removal of trees to make foraging terrestrial (FAO, 2006, Steinfeld *et al.*, 2006) [9, 31]. These days, GHGs that come from cattle than rest could be considered as a causal aspect termed global warming effect (GWE). In 2013, the meat requirement was met by the slaughtering of near 56 billion animals. An elevated meat energy diet is too liable for epidemic of over-weight, obesity in the humanoid populace (Arkadiusz. 2015) [2]. Currently, 70% of all cultivated land, ~30% over-all worldwide outward used for cattle production, 33% of arable land for livestock feedstuff produces and 26% for foraging (FAO, 2006 & Steinfeld *et al.* 2006) [9, 31].

Overeating of meat among modern affluent societies is alleged as risky to human well-being might origin atherosclerosis, cancer (Fergusson, 2010, Corpet 2011, Buscemi *et al.* 2013 & Kim *et al.* 2013) [4, 5, 10, 17] so scientific investigations performed to progress nutritional properties, to heighten eating with attitude actions were attentive to feed animals of the farm, basic feedstuffs of improved pasture value (Jurie *et al.* 2006) [16] providing usual polyunsaturated fatty acids (PUFA) (Krasicka *et al.* 2000) [18]. In the 1990s, 1st cultivated animals stem cells were used with the production of tissue with little amount. NASA presented a study about turkey cells muscle culture (Edelman *et al.* 2005, Webb, 2006) [7, 38], whereas eatable cultured fish filet from cells of goldfish. Evidence to get cultured meat (CM) is not novel but info around the treating and practical truths of meat cultured in laboratories seem mysterious to the overall community. Consumers feel fear continuously till they are not aware of the process of non-natural meat (Van Der Welle and Driessen 2013). Before the production of non-natural meat, awareness sessions are required for the public to admit the idea to eliminate queries (Post 2012) [25].

Culturing meat is a gorgeous alternate to old-style livestock production that has just appeared (Post 2013) [25]. There is a rising curiosity in the profitable use of animal cell culture methods.

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Lately, CM from cells of the stem has been confirmed collected with public performance and organoleptic test (Post 2013) [25]. Also, added values associated with current MP resources are the dawn of multidrug-resilient pathogenic bacteria straining (Sanders, 1999) [26], animal illness spates or plagues, abolish lots of persons (Webster 2002) [39], nutritionally allied ailments i.e. CVDs, diabetic-related to over-eating animal body fat instantly accountable to 3rd universal death (WHO, 2001) [42], foodborne diseases by six-fold heighten peptic-enteritis food harming of advanced nations in past 20 centuries (Nicholson *et al.* 2000) [3, 23], unclean animal products be the greatest communal reasons food-borne ailments (Barnard *et al.* 1995, Mead *et al.* 1999, Nataro and Kaper, 1998, European Food Safety Authority, 2006, Fisher and Meakens, 2006) [3, 8, 19, 22]. Worldwide people are expected to raise 9 billion by 2050, requests for meat growing commonly (Steinfeld *et al.*, 2006) [31].

Yearly worldwide meat making heightens to 465 million tons by the year 2050 joined an increase annual GHG emission to 19.7 gigatons of CO<sub>2</sub>, carbon comparable (Steinfeld *et al.* 2006) [31]. Animals typically liable for the emission of GHG (Williams *et al.*, 2006) [44] consequently decline animals that can be reached in-vitro MP effect a significant deterioration GHG emission. Other details serving *in-vitro* MP comprising animal welfare, procedure supervising, eco-friendly attentions, proficiency food production standings feedstock, diminution in strong land practice GHG emissions (Stamp Dawkins & Bonney 2008) [30]. Therefore, ongoing production of meat up-to-date approaches is successful to more intensify the difficulties, and the *in-vitro* MP system appears to be an attractive substitute and is fetching progressively admissible in bright of the generous bad effects of current MP organization (Z. F. Bhat and Hina Bhat 2011) [48].

The present study was aimed to review the peer-review scientific published literature about the production of in-vitro meat and interpret their pros and cons, nutritive profile, public health, and awareness to get rid of environmental pollutions and contamination.

### Nutritional value

Meat with a good quantity of proteins (balanced vital monomers) besides, unadventurous meat is a foundation of various necessary nutrients i.e., minerals, vitamins, & biological functioning mixes (Young *et al.*, 2013) [47] therefore, increased nutritive value of CM products than conventional products to occupy the position in the market. Nutrients are added in the medium as not produced by muscle cells. For example, crucial cyanocobalamin made completely by few types of intestine-inhabiting bacteria therefore it is originated only in animal products. Supplement with vitamin B12 by fermentation under microbes will be compulsory for cultured products produced in a disease-free atmosphere. The iron content of meat is existing chiefly as part of myo- and hemoglobin (Uzel and Conrad, 1998) [35]. Delivering iron in ferric ions connected to protein bind with plasma, transferrin would possibly deliver in culture medium (Aisen *et al.*, 2001) [1]. Transferrin stages will carefully be watched, though, to lessen points in medium about free ferric or ferrous ions, so theoretically making destructive sensitive oxygen in aerophilic surroundings (Papanikolaou and Pantopoulos, 2005) [24]. Graber and Woodworth (1986) [13] determined

that the concentration of myoglobin in cultured myocytes was little till constant progeny of myotubes was designed, which can aid in regulating ideal progress period obligatory earlier collecting the CM.

### Ethics, public health, and animal welfare

Internationally, Customers have increased attention to diet beliefs with animal morals, integrity human actions (Williamson, 2003). Food morals are relating faith, life with various convictions with obvious nutritional directions that supporters essentially obey. Foods are believed impure, unfit for consumption. There are rules for food organized occasionally for eating numerous types of suitable nutrition. A non-spiritual viewpoint, a "lifestyle" kind of food ethics, as "you are what you eat". Food wants well-matched with a being's prior standards or life strategies. In the western domain, several people do not consume dogs, cats, pet animals while pork is prohibited for Muslims. Customers frequently looking the media for info regarding food problems. So, comprehend media affect buyers' opinions for CM. It will befit meat business establishments for media attention about another meat (Meyers and Abrams, 2010; Goodwin and Shoulders, 2013) [12, 20].

Reporting of CM has been oriented cattle production complications aids of meat cultured (Goodwin and Shoulders, 2013) [12], but consumer approaches would be dissimilar to the product when accessible, recommended that nearness of product imitators' conventional meat, competences allied its production undertake better position (Post, 2012, 2014, Goodwin and Shoulders, 2013) [12, 25]. Presently, ethical interest has been made worse fears influences food connected dangers on public health (Verbeke *et al.*, 2000) [37], with numerous adverse sections of MP, made headings on normal media, including Bovine Spongiform Encephalopathy (BSE).

Escherichia coli and Salmonella eruptions, in human management of livestock, and the involvement in production to worldwide heating (Goodwin and Shoulders, 2013) [12]. Advertising led to amplified community inquiry of the conventional meat industry. Perhaps improved awareness in latent assistances of CM, chiefly relative rising people projected development request of meat (Springer and Duchin, 2014) [28]. Queries regarding CM are not about skill, its adequacy as a food. Will it be unnatural with problems faced by GMOs? People look to need meat from animals, but they are worried about the means some meat-producing animals are raised and slaughtered (Welin *et al.* 2012) [40, 41]. CM has not identified whether customers favor or not. Animals' wellbeing used for MP has been broadly deliberated while non-vegetarians stated decline eating the meat of improved contact alertness movements of animal wellbeing on public media (Tonsor and Olynk, 2011) [34].

An overall harmony that animal anguish must be evaded (DeGrazia, 1996) [6], despite countless enhancements, abattoir does do manage to induce harmful responses between public. Making cultured meat does not encompass the killing of animals, so live animals could be used as a basis for initial cells in a bioreactor. It claimed that people with ethical duty care growth of such food for ethical & proficiency aims (Welin *et al.*, 2012) [40, 41]. Animal welfare usually sets service for cultured-MP as it has not nervous arrangement so cannot sense pain with disadvantages are documented (Stephens, 2010) [32].

### Result of cell culture studies

Muscle cells could be certainly grown up plastics repetitive “*in vitro*” perfect muscle cell culture. In Past, technique extensively believed prototypical observing molecular mechanisms of muscle growth and muscle decline. Currently, this style became a gorgeous substitute for animal MP. Cells of muscle may be cultured with abundantly measured in progress diversity. Furthermore, muscle cell with single film varies significantly from muscle tissue as the latter is a very composite organ. There is an illustration of adipose and connective as well as vascular tissues in skeletal muscle. A question raised, which apparatuses regulate muscle characteristics good-looking for the meat customers? Each component plays in a different way to the meat taste, aroma, flavor & nutritive worth.

Additionally, the meaning of sensory properties of meat differs giving the practice, likings regulars. A raised race as well as task to fulfill consumer perspective. Cell culturing with excessive benefits is cell similarity, a nearly complete regulator of myogenesis. Therefore, comparatively minor populace isolated cells (attained over muscle biopsy) may acquire a substantial amount of muscle threads. Upcoming activities directing body cell nuclear handover in oocytes, nascent stem cells (ESC) via ectopic look distinct features inducible pluripotent stem cells (iPSC) boundlessly distributing cells effectively distinguished in muscle cells, myotubes, muscle fibers (Wilmut *et al.* 1997, Takahashi and Yamanaka 2006, Mizuno *et al.* 2010, Stadtfeld and Hochedlinger 2010, Yamanaka and Blau 2010) [21, 29, 33, 45, 46]. Lately, auspicious procedures for pluripotent stem cell orientation from mouse somatic cells stated (Hou *et al.* 2013, Obokata *et al.* 2014) [15]. Chemically encouraged pluripotent stem cells epi-genetically re-programmed cocktail of convinced prior screened constituents, exogenous “master genes” as Oct4, Sox2, Klf4, and c-Myc replaceable (Hou *et al.* 2013) [15].

By trust elementary homeostatic limits (isoionia, isosmia, isohyria) in satisfactory boundaries, deviations in the arrangement will be likely enhancement with PUFA (n-3) or added significant causes nutritious value (minerals, vitamins,). Organoleptic characteristics of non-natural meat are imaginable modifications. Having slight knowledge in muscle tissue manufacturing excludes medical submissions, an emerging field of investigation for wide training.

### Challenges of artificial meat production

Scenarios of producing meat artificially are seemingly positive, though, there are several contests and drawbacks. The most significant are epidemiology and budget matters. There is a crucial want to grow marketable expertise for culturing meat practically priced with no risk of animal-borne disease. While looks hypothetical an instant, accept biotechnology approaches founded on bioreactors joined dialyzing arrangements permit nonstop muscle cells development in the partial-exposed arrangement. Muscle cells can be circulated to improve more phase differentiation into muscle fibers in sterile situations. Likewise, further meat elements may achieve. Adipocytes are effectively formed as adipose flesh resulting in the stem or mesenchymal cells. Concluding cells simply separated via membrane biopsy. Constituents used to cultivate cells in a culture relatively affluent with some are of animal origin hazardous uncleanness. Alongside, rigid practice “unkindness-free meat” uncertainty muscle tissue grown up

on sera together from neonates, reply an artificial additional (mix of matters that imitator serum movement) or normal plant product source equal properties so serum. Cheap price growing media could accomplish while huge sizes formed structure semi-open in dialyzed bioreactors.

### Rewards/necessity of *in-vitro* meat

Vital benefit from CM remains improved monitoring on meat conformation excellence operating taste, fatty acid arrangement, fat content. Also, well-being features of meat are heightened addition aspects, positive kinds of vitamins in culture medium with a beneficial result on health (Van Eelen *et al.*, 1999) [36, 40].

Next, severe superiority governor guidelines, i.e., Good Engineering Exercise, incredibly presented to current animal homesteads, abattoirs, or meat packaging units, casual of meat corruption, the occurrence of foodborne illness can be meaningfully condensed. Adding dangers contact with hazardous e.g., arsenic, pesticides, dioxins, & hormones related to conventional meat might be knowingly concentrated.

Also, the benefit can be the production of unusual, cultivated meat. conceptually, cells of caged erratic or threatened animals may perhaps yield interesting meats in cultures and a supportable to others worldwide employment of meat of occasional and scarce animals would aid growing rough inhabitants numerous in several nations. It also decreases animal usage in the production of meat classification hypothetically a farmhouse animal might be intended to get the world’s meat source.

An added benefit to decrease the number of nutrients, as well as energy desired for development care as organic constructions adding to muscle tissues, are not vital for producing meat in an *in-vitro* scheme. Also, *in-vitro* arrangements expressively reduce the period for meat growth, feed, and labor. The extra gain of CM is bioreactors, distinct farm animals, no further space needed, and could be set up in fabric room. Hence, nutritious prices for CM be knowingly lesser, cut in capital charges, labor, and land may be rewarded with additional costs of firmer cleanliness rule, harsher switch, computer supervision, etc. The necessity of supplementary protein bases too requests cultured MP as it is, dissimilar other products, animal products esteem arrangement may be favored alternate.

Positive market obtainable to meat alternatives, small bazaar including vegans do not consume meat for right causes request the production of meat. Proteins obtained from plants and fungi are animal approachable, supportable, used to make diversity of good products lacking texture, taste and not desired for meat. More CM motivates harmless to conventional meat due to non-sustainability old-style MP with the vast market. Moderately, negligible land for *in-vitro* system permits production & processing locally in states usually trust introduced meats

### Conclusion and Suggestions

It is concluded from the above literature that current progress in biotechnology organized with repetitive cell and tissue culture practices as well as the public presence of non-natural meat grown up in the laboratory by following steps like processing, and triumphant taste estimation are indicators in care the perspective that meat can be produced artificially. The key problems that come onward are monetary and ethical queries. Selling artificial meat should

be at a reasonable price while another technology is required to put in exercise to huge production. An ethical barrier is similarly significant, numerous vegetarian consumers will not admit synthetic meat without manufacturing is lacking any animal source substrates. Such contests are yet needed to overcome if the screening plant constituent's express cheap media adapted biotechnology methods to the continuous production of non-natural meat are fruitful.

## References

- Aisen P, Enns C, Wessling-Resnick M. Chemistry, and biology of eukaryotic iron metabolism International, Journal of Biochemistry and Cell Biology 2001;33:940–959.
- Arkadiusz Orzechowski. Artificial meat? Feasible approach based on the experience from cell culture studies. Journal of Integrative Agriculture 2015;14(2):217–221.
- Barnard ND, Nicholson A, Howard JL. The medical costs attributable to meat consumption. Prev. Med 1995;24:646–655.
- Buscemi S, Nicolucci A, Mattina A, Rosafio G, Massenti FM, Lucisano G *et al.* Association of dietary patterns with insulin resistance and clinically silent carotid atherosclerosis in apparently healthy people. European Journal of Clinical Nutrition 2013;67:1284–1290.
- Corpet DE. Red meat and colon cancer: Should we become vegetarians, or can we make meat safer? Meat Science 2011;89:310–316.
- DeGrazia D. Taking Animals Seriously: Mental life and moral status, Cambridge University Press 1996, P397.
- Edelman PD, McFarland DC, Mironov VA, Matheny JG. *In vitro*-cultured meat production, Tissue Engineering 2005;11:659–662.
- European Food Safety Authority. The Community Summary report on Trends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial Resistance and Food borne Outbreaks in the European Union in 2005. EFSA J 2006;94:2-288.
- FAO. Livestock's long shadow—environmental issues and options. Food and Agricultural Organization of the United Nations, Rome 2006, P1176.
- Fergusson LR. Meat and cancer. Meat Science 2010;84:308–313.
- Fisher IS, Meakens S. Surveillance of enteric pathogens in Europe and beyond: Enter-net annual report for 2004. Euro Surveillance: Bulletin European sur les Maladies Transmissibles 2006, 11, E060824.060823. Available at: <http://www.hpa.org.uk/hpa/inter/enter-net/Enter-net%20annual%20report%202004.pdf>
- Goodwin JN, Shoulders CW. The future of meat: A qualitative analysis of cultured meat media coverage, Meat Science 2013;95:445–450.
- Graber SG, Woodworth RC. Myoglobin expression in L6 muscle cells, Journal of Biological Chemistry 1986;261:9150–9154.
- Hocquette JF, Bas P, Bauchart D, Vermorel M, Geay Y. Fat partitioning and biochemical characteristics of fatty tissues in relation to plasma metabolites and hormones in normal and double-musled young growing bulls. Comparative Biochemistry and Physiology (A) 1999;122:127–138.
- Hou P, Li Y, Zhang X, Liu C, Guan J, Li H *et al.* Pluripotent stem cells induced from mouse somatic cells by small-molecule compounds. Science 2013;341:651–654
- Jurie C, Ortigues-Marty I, Picard B, Micol D, Hocquette JF. The separate effects of the nature of diet and grazing mobility on metabolic potential of muscles from Charolais steers. Livestock Science 2006;104:182–192.
- Kim E, Coelho D, Blachier F. Review of the association between meat consumption and risk of colorectal cancer. Nutrition Research 2013;33:983–994.
- Krasicka B, Kulasek G, Świerczewska E, Orzechowski A. Body gains and fatty acid composition in carcasses of broilers fed diets enriched with full-fat rapeseed and/or flaxseed. Archive fur Geflugelkunde 2000;64:61–69.
- Mead P, Slutsker L, Dietz A, McCaig L, Bresee J, Shapiro C *et al.* Food-Related Illness and Death in the United States. Emerg. Infect. Dis 1999;5(5):607–625.
- Meyers C, Abrams K. Feeding the debate: A qualitative framing analysis of organic food news media coverage, Journal of Applied Communications 2010;94:22–36.
- Mizuno Y, Chang H, Umeda K, Niwa A, Iwasa T, Awaya T *et al.* Generation of skeletal muscle stem/progenitor cells from murine induced pluripotent stem cells. The FASEB Journal 2010;24:2245–2253.
- Nataro JP, Kaper JB. Diarrheagenic Escherichia coli. Clin. Microbiol. Rev 1998;11:142–201.
- Nicholson FA, Hutchison ML, Smith KA, Keevil CW, Chambers BJ, Moore A. A Study on Farm Manure Applications to Agricultural Land and an Assessment of the Risks of Pathogen Transfer into the Food Chain. Project Number FS2526, Final report to the Ministry of Agriculture, Fisheries and Food, London 2000.
- Papanikolaou G, Pantopoulos K. Iron metabolism and toxicity, Toxicology and Applied Pharmacology 2005;202:199–211.
- Post MJ. Cultured meat from stem cells: Challenges and prospects. Meat Science, 92, 297–301. Cultured beef: medical technology to produce food. Journal of the Science and Food Agriculture 2013. doi: 10.1002/jsfa.6474 [www.theguardian.com/science/video/2013/Aug./05/synthetic-beef-hamburger-tastes-meat-video](http://www.theguardian.com/science/video/2013/Aug./05/synthetic-beef-hamburger-tastes-meat-video).
- Sanders T. The nutritional adequacy of plant-based diets. Proc. Nutr. Soc 1999;58(2):265–269.
- Sarbasov D, Jones LG, Petersen CA. Extracellular signal-regulated kinase-1 and -2 respond differently to myogenic and differentiative signaling pathways in myoblasts. Molecular Endocrinology 1997;11:2038–2047.
- Springer NP, Duchin F. Feeding nine billion people sustainably: conserving land and water through shifting diets and changes in technologies. Environmental Science & Technology 2014;48:4444–4451.
- Stadtfeld M, Hochedlinger K. Induced pluripotency: history, mechanisms, and applications. Genes & Development 2010;24:2239–2263.
- Stamp Dawkins M, Bonney R. Future of Animal Farming; Renewing the Ancient Contract, Wiley Blackwell 2008.
- Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M, De Haan C. Livestock's long shadow:

- environmental issues and options (Rome: Food and Agriculture Organization of the United Nations) 2006, P21.  
[www.virtualcentre.org/en/library/key\\_pub/longshad/A0701E00.pdf](http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf). Accessed March 7, 2008.
32. Stephens N. *In vitro* meat: zombies on the menu? *Scripted* 2010;7:394-401.
  33. Takahashi K, Yamanaka S. Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. *Cell* 2006;126:663–676.
  34. Tonsor GT, Olynk NJ. Impacts of animal well-being and welfare media on meat demand, *Journal of Agricultural Economics* 2011;62:13.
  35. Uzel C, Conrad ME. Absorption of heme iron. *Seminars in Hematology* 1998;35:27-34.
  36. Van Eelen WF, Van Kooten WJ, Westerhof W. WO/1999/031223: Industrial production of meat from *in vitro* cell cultures. Patent Description 1999. <http://www.wipo.int/pctdb/en/wo.jsp?wo=1999031223>
  37. Verbeke W, Ward R, Viaene J. Probit analysis of fresh meat consumption in Belgium: exploring BSE and television communication impact, *Agribusiness* 2000;16:215-234.
  38. Webb S. Tissue Engineers Cook Up Plan for Lab-Grown Meat. *Discover* 2006;27(1):43.
  39. Webster R. The importance of animal influenza for human disease. *Vaccine* 2002;20(2):S16-20.
  40. Welin S, Van der Weele C. Cultured meat: Will it separate us from nature? In: Potthast T, Meisch S, eds., *Climate Change and Sustainable Development: Ethical Perspectives on Land Use and Food Production*. Wageningen Academic Publishers, Wageningen 2012, P348–351.
  41. Welin S, Gold J, Berlin J. *In vitro* Meat: What are the Moral Issues? In: *The Philosophy of Food*. Ed. Kaplan DM. Chapter 16. University of California Press Ltd 2012, P292-304.
  42. WHO. Global Burden of Disease estimates for 2001. Geneva, World Health Organization 2001. [http://www3.who.int/whosis/menu.cfm?path=evidence,burden,burden\\_estimates,burden\\_estimates\\_2001&language=english](http://www3.who.int/whosis/menu.cfm?path=evidence,burden,burden_estimates,burden_estimates_2001&language=english)
  43. Wiliamson M. Space ethics and the protection of the space environment. *Science Policy* 2003;19:47-52.
  44. Williams AG, Audsley E, Sandars DL. Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Main Report. Defra Research Project IS0205. Bedford: Cranfield University and Defra 2006.
  45. Wilmut I, Schnieke AE, McWhir AJ, Kind AJ, Campbell KH. Viable offspring derived from fetal and adult mammalian cells. *Nature* 1997;385:810–813.
  46. Yamanaka S, Blau HM. Nuclear reprogramming to a pluripotent state by three approaches. *Nature* 2010;465:704–712.
  47. Young JF, Therkildsen M, Ekstrand B, Che BN, Larsen MK, Oksbjerg N *et al.* Novel aspects of health promoting compounds in meat. *Meat Science* 2013;95:904-911.
  48. Bhat ZF, Hina Bhat. Tissue engineered meat-Future meat-review. *Journal of Stored Products and Postharvest Research* 2011;2(1):1-10. <http://www.academicjournals.org/JSPPR> ISSN 21410-6567 ©2011 Academic Journals