RESEARCH ARTICLE

SHELF LIFE EXTENSION OF COOKED FOOD: A MODIFIED ATMOSPHERIC APPROACH TO REDUCE MUNICIPAL SOLID WASTE

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ARTICLE INFO	ABSTRACT
	According to 62.2% of the Field Supervisors of Delhi Waste Management Company, food is always thrown into MCD Bins. 44.4% say both unserved and food leftover in the plates is thrown into the bins. As per the quantum of food found in bins placed near the venue of social gatherings, 44.4% say it is between 20-30% while 11.1% say it is between 30-40%. 50% say that more food wastage is found in bins near Banquet Hall / marriage home and 38.9% say in the bins near hotels/ restaurants and clubs. According to study there is high wastage of boiled vegetables, vegetable and dal. During general seasons the food wastage in bins in normally less than 20% but during the marriage seasons it goes up to as high as 40% of the total waste. This paper attempts to tackle with untouched cooked food waste management in our urban cities. Untouched food waste is an enormous contributor to the municipal waste stream, and its generation has significant immediate and long-term economic as well as environmental consequences that many Indians are oblivious to. Food waste is of particular interest to regulatory bodies because nationally the cost of waste disposal has skyrocketed in recent years and will likely only continue to increase.

INTRODUCTION

Food wastage is a serious issue in India.A government study has found that the country wastes Rs 92,651 crore worth or 67 million tonnes of food in a year. This much food is enough to feed a state like Bihar for a full year. Studies also say that Indians waste as much food as the whole of the U.K consumes. On the other hand about 58% of people in the country are food insecure, says the findings of the National Nutritional Survey (NNS) 2011. It is estimated that 46% of children below three years are underweight, 79% of children aged 6- 35 months have anaemic, 23% have a low birth weight and 68 out of 1000 die before the age of one year, and 33% of women and 28% of men have a Body Mass Index (BMI) below normal just because they do not have enough food or nutritional food to eat as per study of ministry of consumer affairs. India, Asia's third-largest economy, has taken a lowly 97th spot in a ranking of 118 countries in the 2016 Global Hunger Index (GHI) released by the International Food Policy Research Institute (IFPRI). The World Bank estimates that India is one of the highest-ranking countries in the world for the number of children suffering from malnutrition. 25% of all hungry people

worldwide live in India. Regions most affected are Madhya Pradesh, Jharkhand, and Bihar. The rural areas, slums; unprivileged areas are in an even worst state. Despite the fact India is the fastest growing economy; it faces a spate of malnutrition incidences. The primary cause of malnourishment is Food Wastage. Though India produces enough food that can feed the twice of present population but this food wastage is the main reason behind the malnourishment of a huge population. We can see the mountains of food being thrown everyday in urban areas whereas in rural areas, slum areas or deprived areas, the people are not getting two times meal a day. Those who can afford to buy the food, waste and throw the nutritious leftover food without a second thought. The picture is very disturbing around the world. About 50% of the food produce grown is being thrown away. Food wastage affects any country to a large extent. The wastage of food involves the wastage of water used for irrigation, wastage of energy, man power and electricity. Taking all into consideration, the actual worth of money per year in India from food wastage is estimated at a whopping Rs. 58,000 crore. The wastage not only creates environmental threat but also cause inflation.In social gathering food goes wasted and increases the solid waste as there is no channel to distribute it to the needy peoples. The caterer needs to vacate the party place overnight and therefore; much of the surplus food is

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thrown away on road or nearby area. The problem of food wastage particularly leftover in the plate or after parties is such a serious issue that India's Prime Minster Sh. NarendraModi has termed it as a crime against society and also an injustice to the poor. In the hospitality sector, food waste is a crucial sustainability concern as well as a drain on the bottom line. Around 100,000 weddings and social events are held in India every day. In India, the bigger the wedding, the larger the party and the more colossal the waste.Only in Delhi-NCR alone, the amount of food wasted at weddings, corporate events and house parties in a day is enough to feed street dwellers across the capital.

Problem of solid Waste disposal system

Food waste is deteriorating the natural ecosystems due to the inefficient use of land and water resources. Disposal of waste is very challenging task and expensive at urban areas. So, it is better to reduce the waste quantity at source level to reduce the quantity for municipal waste. This is also significant that in India only 72% per capita disposal of collection efficiency, so rest of the waste never collected in urban areas. This waste remains on the same place until it got self-disembowelled. This is also seen that in urban cities, left out untouched food isthrown in nearby area and there in no arrangement for collection or disposal for this extra cooked food.The leftover food being thrown poses a serious threat to the environment as well. Proper waste disposal is critical due to the fact that certain types of wastage like meat and poultry residuals can be hazardous and can contaminate the environment if not disposed properly. When food waste goes into landfills, it ends up decaying and releasing methane. That is 21 times more toxic than carbon dioxide in terms of the greenhouse gas potential. This waste also has the potential to cause disease or get in to water supplies. All the moisture and toxins in the food waste which over time get degraded - goes down into the groundwater thereby causing water sources to get polluted. The best way for disposing the waste is to go for composting of producing biogas. With the per tonne of food waste, hotels can generate up to 100 cubic metres of biogas per day, which is equivalent to two commercial LPG cylinders.

Causes of leftover generation

In the past, in social gatherings limited number of traditional food items were prepared and served by the family members. But today among the rich and the rising middle class it is a trend to hire event managers/wedding planners to organise such gatherings in hotels, restaurants, farm houses or clubs. Both the number of dishes and the number of guests on such occasions has increased considerably.There are many reasons responsible for leftover food varying from individual to collective. Following are some of them:

- We fail to assess the number of guests attending any event
- Ordering the food without coordinating to each other resulting in the food more than what the group can eat
- Finding a food item after ordering for it to be unpalatable. As one would put it, 'it did not taste like the last time.'
- While dining at a buffet, filling the plate without assessing the capacity of his/her own
- Too many items in the menu. Generally a four-course meal with starters, soups, main course and desserts.

Nowadays, most guests only eat the starters and often the entire main course is left over.

Causes of food spoilage

Some of the primary food wastage factors are air, oxygen, moisture, light, temperature, and microbial growth. When two or more of these factors are dominant then they can accelerate the spoiling process.When food is exposed to air, microorganisms can land on the food and begin their work of breaking down the food for their own uses. The presence of oxygen enhances the growth of microorganisms, such as moulds and yeasts, contributes directly to deterioration of fats, vitamins, flavours, and colours within foods through the work of enzymes.

Option fordisposal of Leftovers food

Earlier, there was a practice to give the untouched food to friends or eating it the next day after party but now, as the people are becoming more health-conscious, they do not consume such a high calorie food next day and the food goes waste. Still today distributing that food is a good option to avoid wastage. The leftover untouched food after any party can be used to feed the hungry and the needy poor people. For this a number of NGOs are working in different regions.Even a number of hotels, as part of their Corporate Social Responsibility (CSR) initiatives, are in contact with many Non- Governmental Organizations (NGOs). Due to the partnership with such NGOs, when any event of a large scale takes place and the quantity of leftover food is huge, the food is then collected by these associations and donated to schools, old age homes and orphanages. But some people are having their reservation for donation of leftover food as donating can prove to be "extremely dangerous." Once a food has been heated and ready to be served, it gradually loses temperature when it isn't consumed. That's where the bacteria come into the picture and poses a risk. It can be problematic in the future and the repercussions would be so high that the donor may lose its food license.

Challenge for distribution of leftover food

The biggest challenge for the distribution of leftover food is to keep the food safe for consumption. The food spoils due to microbial growth, if not handled properly. The cooked food has the sufficient moisture content that can support the microbial growth. As the cooking cannot kill all the microbes, the remaining microbes can spoil the food when exposed to optimum temperature for growth. The cooked food if not kept under refrigeration spoils at room temperature very fast as this temperature supports microbial growth. The inherent qualities of food like pH, spices/ preservatives used, moisture content etc can vary the shelf-life of food. So it is required to keep the excess/leftover food under refrigeration or any suitable condition like Modified Atmosphere for future use.

Role of packaging to reduce the cooked food wastage

Innovations in packaging were up to now limited mainly to a small number of commodity materials such as barrier materials (new polymers, complex and multilayer materials) with new designs, for marketing purposes. However, food packaging has no longer just a passive role in protecting and marketing a food product. New concepts of active and intelligent packaging are

play an increasingly important role by offering numerous and innovative solutions for extending the shelf-life or maintain, improve or monitor food quality and safety.

Role of active packaging

In this technique indicators and sensors (easy to use small devices) are used instead of time consuming, expensive quality measurements for improving the shelf life and providing current status of food. Temperature, microbial spoilage, food integrity and freshness of the packaged food can be monitor by this method. In this research work an innovative method of MODIFIED ATMOSPHERIC PACKAGING "MAP" has been used to reduce the wastage of food and maintain the hygiene of edible food. A specially designed smart box incorporated with active packaging and coating of specially designed heat resistance polymer has been used which helpedto enhance the shelf life of edible food.By this method, it is possible to reduce the solid as well as liquid waste disposal quantity at urban areas at waste producing source itself. This method is also helpful to reduce the demand of water for cooking the food at source places.

Design and development of food preservative container

This smart food box will be foundation for futuristic strategy in the field of cooked food, raw food and semi-cooked food to enhance the shelf life. Design and development of food preservative container is discussed below,

Basic concept of design and development

Present invention is provided a process of making vessel from bottom to top with outerbody, which covers SS container for holding the cooked food where outside body coated with especially developed heat resistance polymer on upper most layers. There will be a gap between inner and outer wall for filling the chilled/hot water. Present invention is provided a specially designed cover of vessel incorporated with active packaging. Special oxygen scavengers, activated carbon and natural zeolites will be keeping for absorbance. This innovative design of food preservative container box is also applied for patent via Indian patent application no.: 20161100729 and design patent 2017295421.
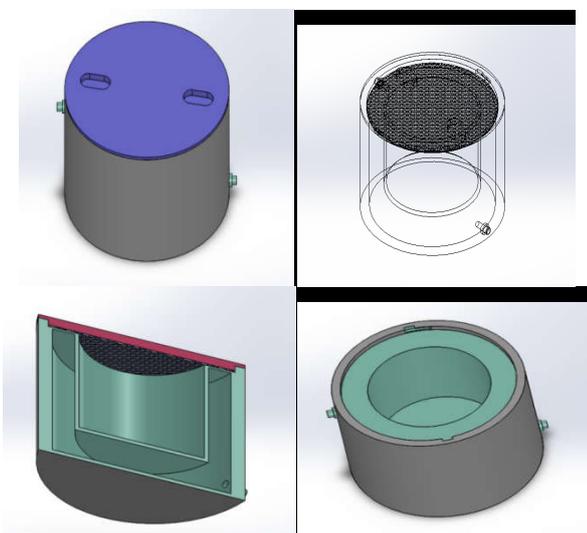

Fig. 2. Different View O Smart Box

MATERIALS AND METHODS

This method was developed for study the shelf life of cooked food with using smart box under the conditions of MAP. Food was also kept in normal box to study the effectiveness of research work.

Theoretical methodologyto enhancement of shelf life using smart box

Cooked foodspoils due to microbial growth. For microbial growth the main reasons are like Temperature, Oxygen, Moisture, Time and Acidity. Developed method for cooked food storage uses different type of scavengers to absorb moisture, oxygen, odour and microorganism form the closed loop. All these scavengers are placed inside of vessel cover, covering with specially designed strainer. So, the absorbance of gases and moisture reaction start soon.When all these factors are controlled then shelf life of cooked food will increase. Oxygen scavengers can be used alone or in combination with MAP. However, it is commercially very common to remove most of the atmospheric oxygen by MAP and then use a relatively small and inexpensive scavenger to mop up the residual oxygen remaining within the food package. Non-metallic oxygen scavengers have also been developed to alleviate the potential for metallic taints being imparted to food products.
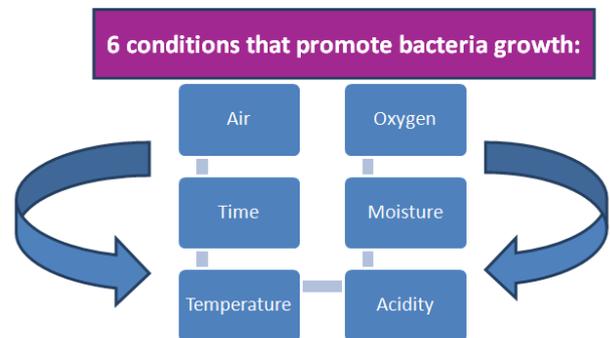

Fig. 1. Factors for food spoilage

In this study, cooked/ boiled vegetables are used as test samples for the study under MAP and without MAP. The changes in the sensory attributes of cooked boiled vegetableswere identified to assess the enhanced shelf life under MAP. Test method is followed by;

- **Cooking:** About 1.5 kg of raw boiled vegetables were washed with tap water properly and followed by rinsing with potable RO water. Potable RO water also added for cooking the raw boiled vegetables approximately 30 minutes on hot plate.
- **Cooling:** Cooked boiled vegetables were divided into 8 parts equally for further testing of shelf life. Those were cooled at room temperature, undercirculated air (using ceiling fan) and in refrigerator for cooling time study as well as uniform cooling. It is found that under circulated aircooling was most uniform and good for reducing the risk of microbial contaminations.
- **Sample preparation by using MAP**: Cooked and cooled boiled vegetables were transferred in smart box for studying the shelf life by sensory evaluation. Total four samples were made for MAP study. Similarly four

other test samples were kept for study in normal food carrying box. Totally 8 nos. of samples were kept at room temperature protected from direct sunlight.

- **Sensory analysis of samples:** Sensory analysis for colour, texture, taste, smell and overall acceptability of cooked food was conducted after every 2 hours by a sensory panel consisting of five numbers of men and women.

RESULT AND DISCUSSION

Performance of design and development was measured as per sensory evaluation but it is also proposed future research for proximate composition analysis like moisture, crude protein, crude fat, calories value as well as Total viable count (TVC).

Cooling of cooked boiled vegetables

Many methods were examined for uniform cooling of cooked boiled vegetables like room temperature, in normal but in fan air and refrigeration. This test conducted with thick layer (4cm) of boiled vegetables in plate and kept in respective place for uniform cooling. It was found that uniform cooling was more in the samples, which were kept in normal condition under fan air. So, it may reduce the risk of bacterial growth due to uniform temperature within the entire surface area of cooked boiled vegetables. Finally all these boiled vegetables were used for trialand the mean of reviewer shown below:

Conclusion

It is observed from the results that food kept in smart box is having higher choice for consumption compare to food kept under normal box. Food which was kept under room condition before preservation shown least rating (31.7) for consumtion in comarion to others conditions. Food kept under fan and heated before surving was having the highest rating (34) with closely competitive by food kept under fan bit not heated before surving to judges. These results shown that good kept in smart box was 'moderately like' in comparision to in same condition it rated as 'neither like or dislike'. With refernce to smell it was 'neighter like or dislike' without MAP box but it was 'like moderately' rating with food was kept in smart box. As per changes in colour of food, it was same as smell rating for normal box it was 'like moderately' for food kept in smart box under MAP conditions. Texture of the food after the study hours was having the highest raing for overall suvey value for food was stored in innovative smart box. Hedionic rating showing that for taste, observation of many was in between like slightly to like modetately under MAP conditions. For food, which was kept in normal box was rated as 'dislike slightly'. In terms of overall acceptability, it was observed from the results that food kept in normal box was having the rating 'dislike slightly'. Whereas food was kept in smart box with modified atmospheric conditions was rated as 'like modelately'.

So, it is may be concluded that food was kept under fan before preservation in smart box with MAP found more effective rather than food kept without MAP conditions. It is also concluded that cooked food can be stored in smart box by using innovative method of smart packaging with modified atmospheric conditions. From all the result of test samples, it is clearly indicated that cooked boiled vegetables, which was kept with the use of specially designed food preservative container with modified atmospheric packaging, was able to enhance the shelf life of cooked boiled vegetables up to 5-8 hours of its cooked time. This study is milestone for the further research in the field of cooked food spoilage globally. Current study is also indicating that modified atmospheric packaging have the potential of save the mass food and can be better solution rather than traditional way of cooked food preservation technique.This study would be beneficial for hotels, event management groups, institutional, daily working passengers as well as government scheme like right for food, mid-day meal for school etc.This proposed work is very useful to control the solid waste management control at the source level. Proposed smart food box can be made for the quantity upto 25- 50 kg of its holding capacity. After successful experimental study in laboratory, it may be implemented to collect the untouched cooked food from the social gathering through smart box by municipalities, Self-help group and NGOs.

Futuristic strategies to reduce the food waste

It is also proposed to develop the mechanism for information to municipal bodies through online pre-registration or mobile app/whatsup group with the help of local NGOs. With this pre-booking system, vehicle may be directed to the same place and will collect the untouched food materials from nearby social gathering and will distribute the food nearby hunger points immediately. However it may be proposed that this food may be supplied to government added organization like orphanage house, old age home, prisoners etc with prior information, so expanses on food may be saved by government. Saved amount can reduce the operating cost of vehicle to distribute the food materials at different locations.

REFERENCES

Ahsen Rayman, Aslihan Demirdoven, Taner Baysal "Use of Indicators in Intelligent Food packaging", *Journal of Food Science,* 70, 1-10.

Ali, M.A., Hasan, S. M. K., Islam, M. N. and Islam, M.N. 2008. " Study on the perod of acceptability of cooked rice", *J. Bangladesh Agril. Univ.* 6(92): 401-408, 2008.

Dr. Marwa Mohamed Kamal el Deen, "The Intelligent Colorimetric Timer Indicator System to develop label Packaging Industry in Egypt", International Design Journal Volume 4 issue 2, Technical Issues.

Feng Q., Lin Y. 2017. Integrated processes of anaerobic digestion and pyrolysis for higher bioenergy recovery from lignocellulosic biomass: A brief review, Renewable and Sustainable Energy Reviews, Volume 77, 2017

Florence Charles, Jose Sanchez, Nathalie Gontard 2006. "Absorption Kinetics of Oxygen and Carbon Dioxide scavengers as Part of Active Modified Atmosphere Packaging", Journal of Food and engineering 72, 2006.

Gennadios, H.J. Park, C.L. Weller, 1993. "Relative Humidity and Temperature Effects on Tesile Strength of Edible Protein and Cellulose Ether Films", *American Society of Agricultural Engineers*, Vol 36(6): 1867-1872- November-December.ISSN 1810-3030.

Hall, K.D., Guo, J., Dore, M., Chow, C.C. 2009. The Progressive Increase of Food Waste in America and Its Environmental Impact. PLOS ONE 4(11): e7940.https://doi.org/10.1371/journal.pone.0007940

Joa, A. Oostendorp, Josselin M. Bode, Eric Lutters, Fred J.A.M. van Houten 2006. " The (development) life cycle

for packaging and relation to product design", Proceedings of LCE 2006, 13th CIRP International Conference on Life Cycle Engineering.

Julian Parfitt, Mark Barthel, Sarah Macnaughton. 2010. Food waste within food supply chains: quantification and potential for change to 2050, August 2010.DOI: 10.1098/rstb. 0126

Kerry, J. P., O'Grady, M. N., Hogan, S.A. 2006. " Past, Current and Potential utilisation of Active and Intelligent packaging Systems for Meat and Muscle-Based Products: A Review (2006). Meat Science 74 (2006) 113-130.

Kiruba, S. Varadharajan, Tinku Thomas, Anura V Kurpad 2013. "Poverty and the State of Nutrition in India", *Asia Pac J Clin Nurt.*, 22 (3) ; 326-339.

Michael Lu, Yvonne Shiau, Jacklyn wong, Raishay Lin 2013. "Milk Spoilage: Methods and Practices of Detecting Milk quality", *Food and Nutrition Sciences*, 2013, 4, 113-123.

Reasons for household food waste with special attention to packaging, HelénWilliams[a], FredrikWikström[a], Tobias Otterbring[b], Martin Löfgren[b], Anders Gustafsson[b], *Journal of Cleaner Production,*Volume 24, March 2012, Pages 141-148

Report on Assessment of Wastage of Food and Ostentatious Behaviour during Social Gathering in National Capital Region Delhi 2011.

Rincal Patel, J.P. Prajapati and Smitha balakrishnan "Recent Trends in packaging of Diary and Food Products", National Seminar on " Indian Dairy Industry- Opportunity and Challenges".

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