Plastic Types and Usage by People in Nakhon Si Thammarat Rajabhat University Area, Nakhon Si Thammarat Province

Jureerat Sanorkan[1], Fahmida Wazed Tina[1*], Suppapat Hemtanon[1],
Maesa Maesutha[1], Kanitta Keeratipattarakorn[1], Anantanit Chumsri[2] and
Veeravan Jongjit Sirijirakal[1]

Abstract

Plastic accumulation or pollution is increasing day by day. Plastics can absorb and transport chemical pollutants and thus create chemical pollution. Plastic pollution is a threat to creatures on lands and in oceans. It is important to investigate and be knowledgeable about plastic usage before plastic pollution management in a particular area. This study investigates (1) the types of discarded plastic products inside the dustbins to know the plastic accumulation in the environment, and (2) plastic usage by people in Nakhon Si Thammarat Rajabhat University area, Nakhon Si Thammarat Province, southern Thailand. People were categorized based on their sex (males and females), age-groups (young and old), and occupations (students, office employees, cleaners, Songtaew drivers, housewives, and sellers). The results showed that dustbins contained eight types of plastic products (plastic bags, boxes, spoons, glasses, bottles, straws, food packages, and styrofoams) and the number of plastic bags was the highest ($p < 0.05$). Between males and females, males used significantly more plastic boxes, spoons, glasses and straws than females ($p < 0.05$). Between young and old people, old people used significantly more styroforms, boxes, glasses and plastic bags than young people ($p < 0.05$). Among people from different occupations, office employees used significantly more styrofoams, glasses, and straws; students, cleaners and drivers consumed significantly more packaged foods; cleaners and housewives used significantly more plastic bags; and cleaners used significantly more boxes and spoons, compared to other occupational groups ($p < 0.05$). This study shows that people from different sexes, age-groups, and

[1] Faculty of Science and Technology, Nakhon Si Thammarat Rajabhat University.

[2] Center of Excellence for Ecoinformatics, School of Science, Walailak University.

[*] Corresponding author e-mail: fahmidatina14@gmail.com

occupations use plastics differently in their everyday life, and their daily consumption behaviors might shape their plastic usage. The findings of this study are very new as nobody has yet addressed how people from different ages, sexes and occupations use plastics in their everyday life in southern Thailand.

Keywords: Dustbins, Nakhon Si Thammarat Rajabhat University, Plastic pollution, Plastic products, southern Thailand

Introduction

Nowadays, large quantities of plastic materials are used everyday worldwide because they are lightweight, inexpensive, durable, and have a long lifespan. Plastics include polystyrene, polypropylene, polyethylene, styrofoam, and polyvinyl chloride (Azzarello and Vleet, 1987). Usually the lifespan of plastics is estimated to be hundreds to thousands of years (Wang *et al*., 2016). These characteristics make plastics a convenient material in everyday life, and because of this reason plastic production is increasing day by day. In 1950, the global plastic production was 1.7 million tons, but now the production is more than 300 million tons (Gourmelon, 2015; Napper *et al*., 2015). The numbers of plastic industries are increasing day by day. China is the largest producer of plastics (25%) followed by Europe (20%) and the US (19.5%) (PlasticsEurope (PEMRG)/Consultic/ECEBD, 2014).

Plastic accumulation in the natural environment is a big global problem now, as it makes plastic pollution. Plastic pollution can change to carbon-dioxide cycle and increase toxic emissions. Another concern is that plastics can absorb and transport chemical pollutants and for this reason they can create chemical pollution in the environment (Rockström *et al*., 2009). Plastic pollution is harmful not only for the land, but also for the water, especially for the marine life because most of the plastics on the land find their final way to the ocean (Jambeck *et al*., 2015). Plastic pollution is an escalating threat to the marine lives, especially to the marine birds as they consume plastics. The animals that ingest different kinds of planktons are more likely to confuse plastic pellets with different kinds of planktons and ingest plastic pellets (Azzarello and Vleet, 1987). Plastic consumption has several physiological effects such as blockage of gastric enzyme secretion, lowers steroid hormone levels, delays ovulation, reproductive failure, and death. Moreover, fish, shellfish and filter-feeders ingest microplastics that can stay inside their tissues, and when we ingest them those microplastics enter in our food chain (Besseling *et al*., 2015; Chang, 2015).

In Thailand, according to Pollution Control Department (PCD), the amount of solid waste was about 38,000 ton/day in 2000, and plastic waste accounted for about 14% of this solid waste. It is very important to recycle the plastic waste for the environment, but unfortunately, the recovery rate of plastic is very less. For example, the recovery rate of plastic waste was only 23% in 2000 (Wongthatsanekorn, 2009). In 2008, the recycling rate of plastic waste was only 22% (Pollution Control Department, 2008). In Nakhon Si Thammarat province, the amount of total garbage is 284,580.88 ton/year. Fifteen percent of this garbage is plastic products, and the recycling rate is only 16% (Matichon online, 2017). It indicates that plastic waste accumulation in nature in Nakhon Si Thammarat province is enormous and it affects the natural environment. For this reason, it is important to know how much plastics are used by people everyday before controlling plastic pollution in Nakhon Si Thammarat area. Usually, there are two main ways to control or manage plastic accumulation and pollution (1) recycle or reuse of plastic materials, or (2) produce plastics those will degrade within short time (Sriroth and Sangseethong, 2005). According to us, increase awareness of people about plastic pollution or influence them to reduce their everyday plastic usage could be another way to control plastic pollution, but before increasing their awareness it is important to know their everyday plastic usage.

The aims of this study are to know (1) the types of discarded plastic products (e.g., glass, straw, box, spoon, bag, bottle, etc.) in the environment, and (2) the plastic usage by people in Nakhon Si Thammarat Rajabhat University area, Nakhon Si Thammarat Province. This study is the first one to show how people from different sex, different age, and different occupation use different types of plastic products based on their daily requirements in southern Thailand.

Materials and methods
   1. **Study area**
      This study was conducted in Nakhon Si Thammarat Rajabhat University (NSTRU) area, Tha Ngio, Nakhon Si Thammarat province. Data were collected in November, 2018.
   2. **Data collection**
      Different types of discarded plastic products were collected from 12 large-sized (height 108 cm, width 58 cm, and depth 73 cm) dustbins. Simple random sampling method was used to select the dustbins. In this study, only blue-colored dustbins were selected as they contain recyclable materials. After selecting a dustbin, all the

plastic materials were separated and counted based on their types. Eight types of plastics were observed in the dustbins-glass, straw, box, spoon, bag, bottle, food package, and styrofoam (*polystyrene plastic*).

For investigating the plastic usage by people in Nakhon Si Thammarat Rajabhat University area, 120 people were selected randomly. The people were categorized based on their sexes (males 50, females 70), age groups (young 44 (20-35 years old), old 76 (>35 years old)), and occupation (students 20, official employees 20, cleaners 20, sellers 20, songtaew drivers 20, and housewives 20). Official employees were defined as people who work in offices, cleaners were defined as people who clean roads, dustbins, or offices/hotels/apartments, sellers were defined as people who sell in department stores or in local markets. These people were asked regarding their everyday plastic usage (what types and how many plastic products they use everyday), especially about the plastics those were observed in the dustbins. Their answers were recorded for further analysis.

3. Data analyses

Before analysis, normality of all data was checked and parametric statistics were used when normality or other assumptions of parametric tests were met. T-tests were performed to test the differences in the numbers of different types of plastics between (1) males and females, and (2) young and old people. One-way ANOVA with post-hoc Tukey was used (1) to test the differences in the numbers of plastics among different types of plastic products collected from the dustbins, and (2) to test the differences in the numbers of plastic products used by people from different occupations. The data were reported as mean±standard error (SE), and all tests were considered statistically significant at $p < 0.05$.

Results

1. Plastic types inside dustbins

The numbers of different types of plastics were significantly different ($F_{7,88} = 25.82$, $p < 0.001$). Plastic bags were higher in numbers than the numbers of other plastics. The numbers of plastic packages, bottles, or straws were significantly higher compared to the numbers of spoons, styrofoams, or boxes ($p < 0.05$) (Figure 1).
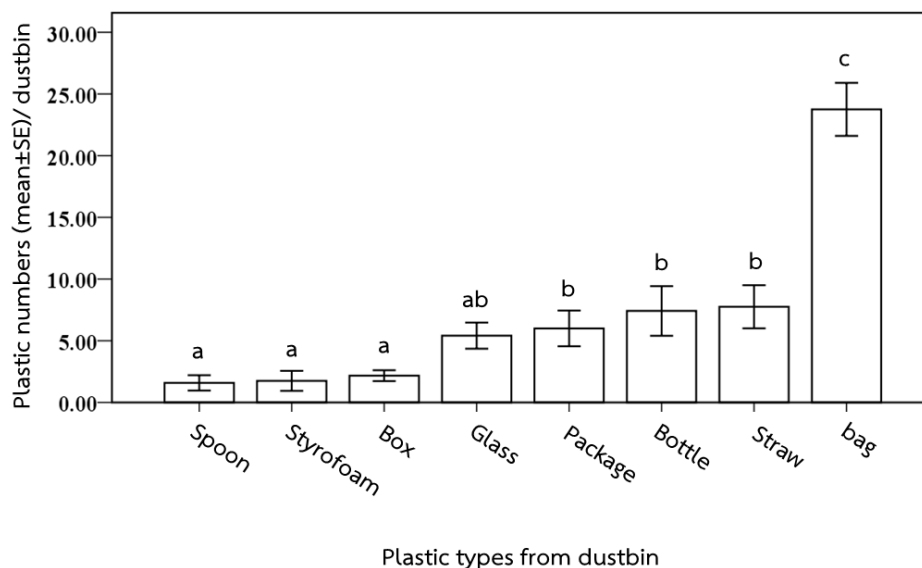
Figure 1 The numbers of different types of plastic products. Different lowercase letters represent the mean differences in plastic numbers ($p < 0.05$) among different plastic types.

2. Plastic usage by males and females everyday

Males used higher numbers of plastic boxes, spoons, glasses and straws than females, whereas the numbers of styrofoams, packages, bottles, and plastic bags were not different (Table 1).

Table 1 Differences in everyday plastic usage between males and females

Plastic types	Females	Males	Statistical analyses
Box	1.93 ± 0.31^a	3.53 ± 0.38^b	t_{118} = -3.21, $p < 0.005$
Spoon	1.15 ± 0.15^a	1.84 ± 0.20^b	t_{118} = -3.45, $p < 0.005$
Glass	1.24 ± 0.14^a	1.72 ± 0.16^b	t_{118} = -2.18, $p < 0.05$
Straw	1.23 ± 0.12^a	1.93 ± 0.16^b	t_{118} = -3.33, $p < 0.005$
Styrofoam	2.28 ± 0.30^a	2.52 ± 0.33^a	t_{118} = -0.56, $p > 0.05$
Package	1.83 ± 0.13^a	2.14 ± 0.20^a	t_{118} = -1.01, $p > 0.05$
Bottle	1.82 ± 0.11^a	1.72 ± 0.16^a	t_{118} = 0.51, $p > 0.05$
Plastic bags	4.65 ± 0.46^a	4.04 ± 0.41^a	t_{118} = 0.94, $p > 0.05$

Note: Different lowercase letters represent the mean differences in plastic usage ($p < 0.05$) between males and females.

3. Plastic usage by young and old generations everyday

Old people used more styroforms, boxes, glasses and plastic bags compared to young people (Table 2), but the numbers of spoons, packages, bottles, and straws were not different between young and old people (Table 2).

Table 2 Differences in everyday plastic usage between young and old people

Plastic types	Young people	Old people	Statistical analyses
Styrofoam	1.61 ± 0.35^a	3.26 ± 0.36^b	$t_{118} = -3.01, p < 0.005$
Box	1.68 ± 0.24^a	3.34 ± 0.37^b	$t_{118} = -3.22, p < 0.001$
Glass	1.13 ± 0.14^a	1.61 ± 0.13^b	$t_{118} = -2.15, p < 0.05$
Bag	3.06 ± 0.41^a	5.17 ± 0.42^b	$t_{118} = -3.27, p < 0.005$
Spoon	1.14 ± 0.13^a	1.62 ± 0.18^a	$t_{118} = -1.82, p > 0.05$
Package	1.61 ± 0.23^a	2.15 ± 0.19^a	$t_{118} = -1.72, p > 0.05$
Bottle	1.60 ± 0.24^a	1.88 ± 0.14^a	$t_{118} = -1.23, p > 0.05$
Straw	1.47 ± 0.90^a	1.64 ± 0.15^a	$t_{118} = -0.73, p > 0.05$

Note: Different lowercase letters represent the mean differences in plastic usage
($p < 0.05$) between young and old people.

4. Plastic usage by people from different occupations everyday

In the case of plastic spoons, cleaners used higher number of spoons compared to other occupational groups, whereas, sellers and housewives used lower number of spoons compared to other occupational groups ($p < 0.05$) (Table 3).

In the case of styrofoams, office employees used higher number of styrofoams compared to other occupational groups, whereas, students and sellers used lower number of styrofoams compared to other occupational groups ($p < 0.05$) (Table 3).

In the case of using of plastic boxes, cleaners and drivers used higher number of boxes compared to other occupational groups, whereas, sellers used lower number of boxes compared to other occupational groups ($p < 0.05$) (Table 3).

In the case of glasses, office employees used higher numbers of glasses compared to other occupational groups, whereas, sellers used lower number of glasses compared to other occupational groups ($p < 0.05$) (Table 3). In the case of plastic packages, office employees and sellers used lower number of packages compared to other occupational groups ($p < 0.05$), whereas, package numbers were not different among students, cleaners, housewives and drivers (Table 3).

In the case of plastic bottles, cleaners and sellers used lower number of bottles compared to other occupational groups ($p < 0.05$) (Table 3).

In the case of straws, office employees used higher number of straws compared to other occupational groups, whereas, housewives used lower number of straws compared to other groups ($p < 0.05$) (Table 3).

In the case of plastic bags, cleaners used higher number of plastic bags compared to other occupational groups, whereas, sellers used lower number of plastic bags compared to other occupational groups ($p < 0.05$) (Table 3).

Table 3 Differences in everyday plastic usage among people from different occupations

Plastic types	Students	Official employees	Cleaners	Sellers	House-wives	Drivers	Statistical analyses
Spoon	1.35 ± 0.16^{ab}	1.15 ± 0.24^{ab}	2.85 ± 0.41^{c}	0.85 ± 0.23^{a}	0.65 ± 0.19^{a}	1.80 ± 0.32^{b}	$F_{5,114} = 8.43$, $p < 0.001$
Styro-foam	0.85 ± 0.53^{a}	6.55 ± 0.79^{d}	3.90 ± 0.68^{c}	0.30 ± 0.10^{a}	2.50 ± 0.35^{b}	1.85 ± 0.39^{b}	$F_{5,114} = 21.91$, $p < 0.001$
Box	2.25 ± 0.24^{b}	1.30 ± 0.42^{b}	6.30 ± 0.51^{c}	0.35 ± 0.13^{a}	1.20 ± 0.34^{b}	5.00 ± 0.61^{c}	$F_{5,114} = 32.95$, $p < 0.001$
Glass	1.65 ± 0.15^{b}	2.35 ± 0.27^{c}	1.60 ± 0.31^{b}	0.30 ± 0.11^{a}	1.25 ± 0.28^{b}	1.50 ± 0.21^{b}	$F_{5,114} = 8.04$, $p < 0.001$
Pack-age	2.75 ± 0.32^{c}	1.50 ± 0.25^{b}	2.65 ± 0.29^{c}	0.25 ± 0.16^{a}	1.95 ± 0.50^{b}	2.65 ± 0.31^{c}	$F_{5,114} = 8.93$, $p < 0.001$
Bottle	1.95 ± 0.08^{b}	2.10 ± 0.32^{b}	1.35 ± 0.13^{a}	1.15 ± 0.29^{a}	2.25 ± 0.30^{b}	1.90 ± 0.23^{b}	$F_{5,114} = 3.10$, $p < 0.05$
Straw	1.70 ± 0.16^{b}	2.80 ± 0.26^{c}	1.50 ± 0.30^{b}	1.50 ± 0.25^{b}	0.80 ± 0.11^{a}	1.20 ± 0.20^{b}	$F_{5,114} = 8.22$, $p < 0.001$
Bag	3.00 ± 0.36^{b}	3.50 ± 0.54^{b}	8.30 ± 0.79^{d}	2.20 ± 0.44^{a}	6.00 ± 1.01^{c}	3.40 ± 0.44^{b}	$F_{5,114} = 12.67$, $p < 0.001$

Note: Different lowercase letters represent the mean differences in plastic usage ($p < 0.05$) among people from different occupations.

Discussion

In the dustbins, the number of plastic bags was the highest. It indicates that people in NSTRU area use higher numbers of plastic bags compared to other plastic products and discard them in the environment. Leallaphan and Launglaor (2015) also shows that people in Bangkok use higher number of plastic bags. In Thailand, usually when people buy something, they are provided plastic bags everywhere without any cost. During investigating the plastic bag usage by males and females, we observed that both males and females used on average 4-5 plastic bags everyday, and their plastic bag usage was not different. On the other hand, old people used more plastic bags than young people. The reason behind this could be that 50% of

the young people are students (20 out of 40 young people) who usually eat breakfast and lunch in the university canteen, and therefore, it is not needed for them to buy foods from outside and carry those foods inside plastic bags. However, during dinner time, they buy foods or drinks from outside and carry those foods inside plastic bags. Among the different occupational groups, cleaners and housewives used more plastic bags than other groups. In the case of cleaners, usually they come in their working place in early morning and work for the whole day. Therefore they need to buy foods and drinks from outside and carry those foods inside plastic bags. In the case of housewives, usually they cook in homes, and for this reason they go for shopping and buy various types of raw foods (e.g., vegetables, meat, fish etc.) and carry those foods inside plastic bags. Accumulation of plastic bags in environment is harmful. They get into the soil and release toxic chemicals slowly. Moreover, in marine environment, some marine animals confuse plastic bags with their real food and consume plastic bags (Azzarello and Vleet, 1987). As plastic bags cannot be digested by an animal, they stay in the gut and prevent food digestion. It causes slow and painful death of animals.

In the case of sexual differences in using plastic products (except plastic bags), males used more plastic boxes, spoons, glasses and straws compared to females. The reason behind this could be that males probably prefer to eat outside more than females and that is why they buy more boxes containing foods, and glasses containing drinks. In Thailand, usually, spoons and straws are provided free with foods and drinks. Few previous studies (Lee, 2009; Lynn *et al*., 2016) also reported differences in plastic usage between males and females.

In the case of age differences in using plastic products, it was observed that old people used more styrofoams, boxes, and glasses compared to young people. In the case of young people, half of them are students in this study, and they usually do not buy foods from outside during breakfast or lunch. They prefer to eat in the canteen because canteen is near to their classrooms or dormitory, and foods are comparatively cheaper. Whereas, most of the old people are belong to earning group (e.g., official employees) who prefer to buy foods from outside. Usually they buy breakfast (foods inside boxes or styrofoams) from outside and carry those foods in their working places. Similarly, during going back to home after finishing work, they buy foods and carry those foods inside boxes or styrofoams. Another reason behind using less plastics in young people could be that young generation is more ready than old generation to accept new ideas (use less plastics, or use green products)

for protecting environment (Ottman *et al.*, 2006). Martinsons *et al.* (1997) observed that most of the supporters of environmental protection tend to be young in age.

In the case of plastic usage by people from different occupations, we observed that students, cleaners, and drivers used more food packages (on average 3 packages/day) than other occupational groups. Usually, students like to buy several types of dry foods (cookies, chocolates, cakes, nuts, pickles etc.) from department stores frequently. On the other hand, cleaners and drivers probably prefer to buy some cheaper foods (e.g., breads, cakes, cookies) when they work outside and get hungry. Cleaners also used more plastic boxes, spoons, and bags compared to other occupational groups. The reason behind this could be that they work outside/move from one place to another for cleaning purposes and that is why they buy and carry foods along with spoons inside boxes or plastic bags. Official employees used more styrofoams, glasses and straws compared to other groups, because they might prefer to buy and carry foods and drinks from outside during coming to their working places, and during going back to their homes.

Seller groups used significantly less numbers of plastic products compared to other groups. The reason behind this could be that they sell their products most of the time and do not go outside for buying foods or drinks. When they eat, they eat inside their shop and use their own plates or glasses for eating and drinking.

Conclusion

This study shows that (1) among various types of plastic products, plastic bags are discarded more in the environment and (2) usage of some plastic products differs between males and females, between young and old people, and among several occupational groups in Thailand. These findings are very new as no research has focused on plastic usage of people from different sexes, ages and occupations in Thailand before. In this study, possible explanations are offered based on our observations, as sufficient review articles are not found on this topic (only one is found on sexual differences in plastic usage). This study will help to target user groups of specific plastic products to educate them about how to reduce the consumption of that plastic product. For example, a training program might increase the awareness of housewives and cleaners regarding plastic pollution, as well as teach them how to reduce plastic bag consumption as they use a higher number of plastic bags everyday. They might use one plastic bag several times or might buy environment friendly (green) reusable bags for shopping. Similarly, official employees may carry their own box and glass/bottle everyday and whenever they

buy foods/drinks they may ask the sellers to give foods and drinks in their own containers. Further research could be conducted to see the differences in plastic usage among different provinces and people with different cultures.

Acknowledgements

References

Azzarello, M.Y. and Vleet, E.S.V. (1987). Marine birds and plastic pollution. *Marine Ecology Progress Series*, 37, 295-303.

Besseling, E., Foekema, E.M., Franeker, J.A.V., Leopold, M.F., Kühn, S., Rebolledo, E.L.B, Heße, E., Mielke, L., IJzer, J., Kamminga, P. and Koelmans, A.A. (2015). Microplastic in a macro filter feeder: humpback whale Megaptera novaeangliae. *Marine Pollution Bulletin*, 95(1), 248-252.

Chang, M. (2015). Reducing microplastics from facial exfoliating cleansers in wastewater through treatment versus consumer product decisions. *Marine Pollution Bulletin*, 101(1), 330-333.

Gourmelon, G. (2015). *Global plastic production rises, recycling lags. New Worldwatch Institute analysis explores trends in global plastic consumption and recycling.* Retrieved 10 December 2017, from: http://www. worldwatch. org.

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R. and Law, K.L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768-771.

Leallaphan, A. and Launglaor, W. (2015). Attitudes and behavior of Bangkok Residents regarding reducing the use of plastic bags. *University of the Thai Chamber of Commerce Journal*, 34 (1), 70-87.

Lee, K. (2009). Gender differences in Hong Kong adolescent consumers' green purchasing behavior. *Journal of Consumer Marketing*, 26(2), 87-96.

Lynn, H., Rech, S. and Samwel, M. (2016). *Plastics, gender and the environment. Life cycle of plastics and its impacts on women and men from production to (marine) litter.* Netherlands: Women Engage for a Common Future International.

Martinsons, M.G., So, S.K., Tin, C. and Wong, D. (1997). Hong Kong and China: emerging markets for environmental products and technologies. *Long Range Planning*, 30(2), 277-156.

Matichon online. (2017). *Nakhon Si Thammarat - waste water overflowing the city stinking smell after another heavy flood, the public complained of dreaded epidemics*. Retrieved 26 February 2017, from: https://www. matichon.co.th/local/news_439040.

Napper, I.E., Bakir, A., Rowland, S.J. and Thompson, R.C. (2015). Characterisation, quantity and sorptive properties of microplastics extracted from cosmetics. *Marine Pollution Bulletin*, 99(1-2), 178-185.

Ottman, J.A., Stafford, E.R. and Hartman, C.L. (2006). Avoiding green marketing myopia: ways to improve consumer appeal for environmentally preferable products. *Environment: Science and Policy for Sustainable Development*, 48(5), 22-36.

PlasticsEurope (PEMRG)/Consultic/ECEBD. (2014). *Plastics-the Facts 2014/2015 An analysis of European plastics production, demand and waste data*. Retrieved 16 December 2018, from: www.plasticseurope.org/application/files/application/files/5515/1689/9220/2014plastics_the_facts_PubFeb2015.pdf.

Pollution Control Department. (2008). *Guide to reducing waste sorting and utilization*. Retrieved 26 February 2019, from: http://www.mt.mahidol.ac.th/MT_Green/images/knowledge/Guide to reducing waste sorting and utilization.pdf.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J. and Nykvist, B. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472.

Sriroth, K. and Sangseethong, K. (2005). Biodegradable plastics from cassava starch. In *II International Symposium on Sweetpotato and Cassava: Innovative Technologies for Commercialization* (pp. 145-152). Kuala Lumpur, Malaysia: International Society for Horticultural Science.

Wang, J., Tan, Z., Peng, J., Qiu, Q. and Li, M. (2016). The behaviors of microplastics in the marine environment. *Marine Environmental Research*, 113, 7-17.

Wongthatsanekorn, W. (2009). A goal programming approach for plastic recycling system in Thailand. *International Journal of Industrial and Manufacturing Engineering*, 3(1), 23-28.