Potato food waste in Swiss households – quantity, driving factors and waste behavior of consumers

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Keywords

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Topic

Models of food consumption behavior and their predictive power

Abstract

This study quantifies the amount of potatoes being lost in Swiss households and examines drivers and causes of these losses. Therefore, three types of losses occurring in private households have been investigated: (1) potatoes which have been disposed without being prepared, (2) peeling and preparation losses and (3) leftovers. With the aid of a questionnaire sent to 2000 randomly chosen Swiss households and a voluntary 30-days-diary study, the influence of socio-demographic factors, as well as factors focusing on consumers preferences and behaviors have been analyzed. Descriptive statistics have been used to examine first trends, a factor analysis was conducted to reduce the amount of variables representing consumers' preferences to underlying factors and Generalized Linear Models (GLM) have been assembled to estimate the influence of several predictors on the three types of losses. Our results show that socio-demographic factors have a significant impact on potato losses in private households. In particular the age is a strong predictor for all three losses. Household

size, the number of minors, the number of meals, the number of persons usually participating the meals, the sex of the person usually preparing the meals, the income and the educational level have a significant impact on at least one out of the three different loss rates. Significances could also be found for consumers' preferences for perfect appearance of potatoes and high-quality products as well as for behavioral factors like the goodness of storage conditions, the handling with leftovers and peelings and the amount of potato consumption.

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Introduction

Various studies examined the amount of food disposed by consumers in the past (Van Garde & Woodburn, 1987; Wenlock et al., 1980). The results differ as a function of the assessment method. Studies using diaries to assess the amount of food waste generate different results than inferential calculations of household consumption. However, most of these studies were conducted even more than 25 years ago and things may have changed due to technical innovations or changing household structures. More recently conducted studies (Beretta et al., 2012; Gustavsson et al., 2011; Quested & Murphy, 2014; WWF, 2014) focused on the amount of household food waste at national scale while driving forces for food waste where not analyzed. This study aims at determining driving forces for potato household food waste in Switzerland. For that reason, in October 2014 a representative household survey was conducted in the German-speaking part of Switzerland, for which 2000 households were randomly chosen from the telephone book and a standardized questionnaire was sent via mail. Therein, people were asked about their potato purchase, storage, consumption and disposal habits and to which extent potato quality criteria, food safety reasons, cautiousness and lack of knowledge influence these habits.

Peeling and preparation losses, leftovers and storing losses will be determined for fresh potatoes and processed potato product (Chips, French Fries, Mashed potatoes, other products). The impact of socio-demographic factors such as income, household size, age will also be analyzed as previous studies have indicated a significant influence of these factors (Van Garde & Woodburn, 1987; Wenlock et al., 1980). The participants of the survey had the choice to participate in an ongoing diary study where the amount of waste was documented in more detail over a whole month. The findings of both, survey and diary help to examine the driving factors of consumers' waste behavior. To assess the impact of various drivers on the amount of waste, factor and regression analysis was conducted. Therefore, losses were allocated due to the examined reasons.

In the first instance, an overview of causes and drivers of food waste in households is given. Subsequently, the methodology is explained and the results are presented. In the last section of this paper, the main findings are discussed and linked to other studies in this field.

Causes and Drivers of Potato Food Waste in Households

Potato waste could be caused in private households for three reasons. (1) Consumers throw away raw potatoes because they have become inedible ("pouch losses"). (2) Consumers generate losses due to meal preparation ("peeling and preparation losses"). (3) Consumers do not eat all potatoes they have prepared for meal and generate therefore losses ("leftovers").

Drivers for losses in private households are grouped into the three categories (Canali et al., 2014) consumer preferences, consumer behavior and socio-demographic trends (Table 1). When purchase frequencies, purchase volumes or purchase responsibilities of private households mismatch with storing facilities, cooking frequencies or cooking responsibilities, higher potato losses are expected due to inappropriate consumer behavior. When consumers do not know how to store potatoes to keep them editable over a certain period of time, losses increase due to lack of knowledge.

Definition	Driver
Drivers related to socio-demographic factors, e.g. food waste causes related to households' characteristics	- Household size - Age - Number of Minors - Education - Income - Number of meals per week - Number of persons per meal - Gender
Drivers related to unconscious preferences that can hardly be modified as the preferences for certain aesthetic standards or typologies of food.	Preferences for - Laundered potatoes - Specific calibrations - Blemish-free potatoes - Nice packages - Specific sort - Particular origin - Organic produce
Drivers related to consumers' individual behaviors modifiable through information and strengthened awareness. The drivers classified in this group, although defined with very generic terms, refers for example to consumer attitudes towards food shopping, the way food is served by restaurants, the level of general information and awareness about food, social norms, and so on.	- Purchase frequencies and volumes mismatch with cooking frequencies and volumes or storing facilities - Purchase responsibilities mismatch cooking responsibilities - Lack of knowledge how to store potatoes to keep them editable. For example, storing in the fridge.

Table 1: Causes and driver of household potato losses. Source: Canali et al. (2014).

Canali et al. (2014) formulated several hypothesis how socio-economic drivers influence food waste in general. Those which are valid especially for potatoes will be tested in our study:

- Single households tend to waste more, larger households wasting less per person than smaller households.
- Households with children tend to waste more than households without children.
- Young people tend to waste more than older people.

- Low income households tend to have lower food losses than higher income households.
- The older generation may have better food skills. There are no food 'shortages' as there have been in the past

Consumer preferences leading to higher losses are:

- Consumers want variety in their meals (e.g. may not want to eat leftovers; same thing two days in a row) (Canali et al., 2014)
- Consumers demand for blemish-free products (Hurschler, 2012)

Methodology

Representative consumer survey

In October 2014, a questionnaire asking for potato purchase, storage and consumption behavior and preferences as well as their losses was sent via mail to 2000 Swiss households which were randomly chosen with the aid of the telephone book. The person who usually prepares the meals within the household was asked to complete the questionnaire. To gain data about losses, people should estimate which amount of a specific potato product (e.g. fresh potatoes, Chips, French fries) had been disposed over a longer period without being prepared. Participants could choose from 0% to 40% losses in 10% steps or just bigger than 40%. Furthermore, they should provide a guess on preparation losses (just for fresh potatoes; occur while preparing the meal) and leftovers (for fresh potatoes as well as for processed potato products; losses after cooking/preparing the meal). The response scale for these preparation losses and leftovers reaches from 0% to 25% losses in 5% steps or just bigger than 25%. The survey took place in October 2014. The response rate was 36.16 %. A reminder was not necessary. Thus, 765 questionnaires have been sent back, whereof 45 could not be delivered and 16 refused the survey by sending it back and providing a reason (e.g. too old). The remaining 704 questionnaires have been scanned and memorized into a SPSS file (SPSS Inc., Chicago, IL, USA).

Voluntary consumption diary

215 respondents of the consumer survey agreed in participating in a further research for gaining detailed data about consumption and deposing of potatoes in households with the aid of a diary. Within that diary, people should daily document over a 30 day period whether they prepared fresh potatoes, processed potato products (French fries, mashed potatoes, other products) or no potatoes at all. If they prepared a meal containing potatoes, they were asked

for the initial quantity, the amount of peeling and preparation losses, the effectively eaten quantity, the leftovers (all in gram) and the treatments of those leftovers. As a controlling function, the sum of peeling and preparation losses, effectively eaten quantity and leftovers should equal the initial amount. Together with the diary, an instruction booklet with many examples was sent to participations to minimize the risk of wrong or variably completed diaries. After two month, 67 diaries have been sent back and were analyzed with SPSS. Therefore, data of the first consumer survey have been linked with the diary data.

Descriptive statistical analysis

Descriptive statistics were used to determine the distribution of losses and to check the representativeness of the sample. Frequencies, center scores and deviations were calculated and presented. Figure 1 to Figure 3 show that household potato losses are not normally distributed in the sample. For pouch losses, the variance (s^2=82.84) exceeds more than nine times the mean losses (M=8.48) which might indicate over-dispersed data. We assume that the unit of our three dependent variables is the count of potatoes (they all have hypothetically the same size and weight) which are disposed out of 100 potatoes. The distribution of the leftovers also indicates over-dispersion (M=3.06; s^2=20.07). For peeling and preparation losses the situation is not that clear. The mean (M=7.10) is lower than the variance (s^2=16.97) but not that much as for the other two dependent variables. Further analysis is needed to check whether peeling and preparation losses are over-dispersed as well or not.

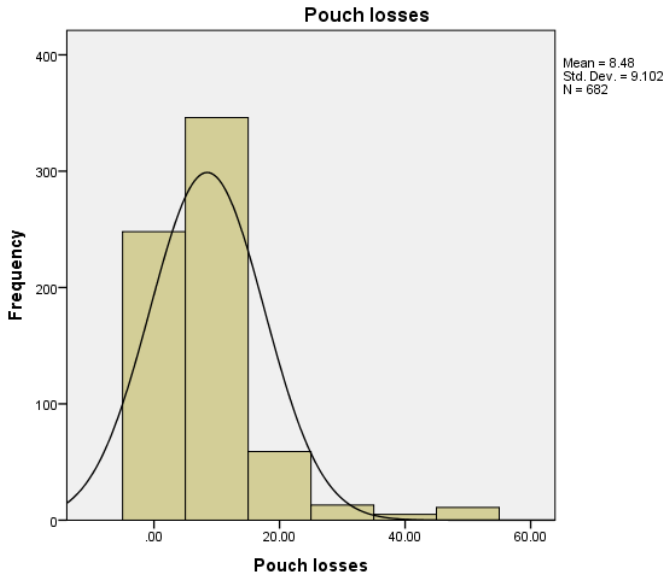

Figure 1: Histogram of pouch losses.

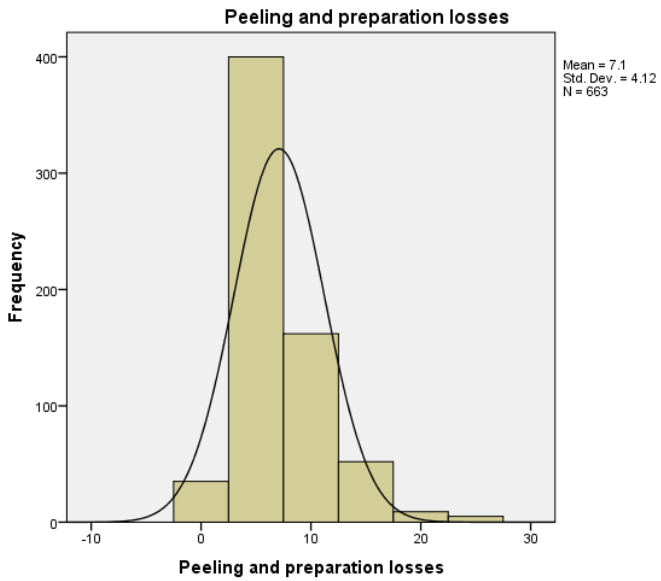

Figure 2: Histogram of peeling and preparation losses.

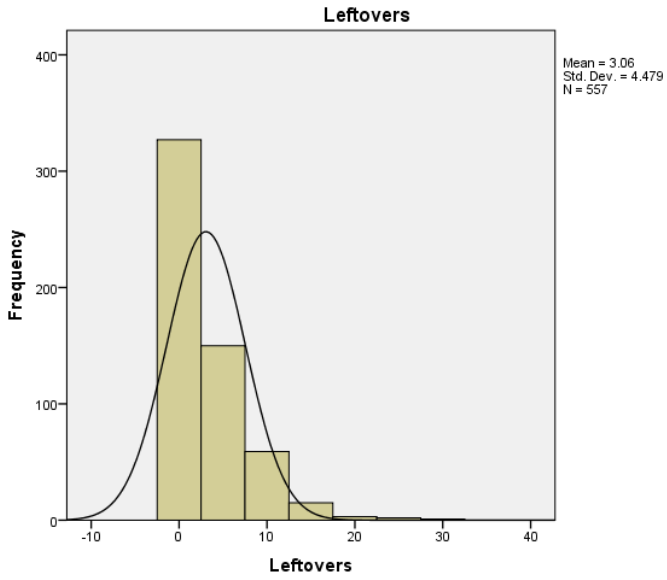

Figure 3: Histogram of Leftovers.

Factor analysis

Within the survey, people should evaluate the importance of 14 attributes concerning consumer preferences. With the aid of a factor analysis, we reduced these 14 variables (each of them could be rated on a scale from -2 to 2) to underlying factors. Therefore, we defined that we extract all factors with an Eigenvalue bigger than 1. The principal component analysis was chosen in order to explore our data and provide conclusions according to our observed sample (Field, 2013). For improving the interpretation the Varimax rotation was chosen. To keep the independence of the variables we choose an orthogonal rotation. Varimax tries to

load a smaller number of variables highly on each factor (Field, 2013). The resulting groups of factors are more interpretable than using a Quartimax rotation. After factor analysis, the extracted factors scores should be added to each case in our data. Afterwards, we can use these factor scores for further analysis. As saving method we choose "Regression" as correlations between factor scores are acceptable (Field, 2013). Finally, we decided to exclude the variable "Price" from the factor analysis as this variable could be seen on another dimension than the other 13 (Table 8).

Generalized Linear Models (GLM)

To examine the influence of several predictors on the three different dependent variables (pouch losses; peeling and preparation losses; leftovers), three GLMs were built. As the distributions of the three dependent variables indicate, there is no normal distribution which makes data transformation necessary. As over-dispersion seems to occur for pouch losses and leftovers, it was chosen a negative binomial model with log link for these two variables (Long, 1997). The negative binomial regression just has an extra parameter to model the over-dispersion. Initially, we tried the same model for the peeling and preparation losses but the estimate of the dispersion coefficient was 0 which indicates no over-dispersion. That is why we choose a Poisson log-linear regression for the peeling and preparation losses (Long, 1997). In general, negative binomial regression can be seen as a generalization of Poisson regression since both has the same structure (Long, 1997). Both, Poisson regression and negative binomial regression, are in general used for count data. For that reason, we defined our units for the three loss rates as the count of potatoes that are lost out of 100 hypothetically equal potatoes. The predictors included in each model are described in Table 10, Table 15 and Table 20.

Results

Household parameters

More than three-quarter (77%) of the respondents are mostly responsible for food purchases in their households. Further 17.6% stated that they are partly responsible for food shopping, 3.3% do not purchase food. 2.1% did not answer to this question. The sample was also asked for the responsibility of food preparation. 75.1% of the sample are mostly responsible, 17.9% are partly responsible for food preparation in their household. 4.4% of the sample are not responsible for food preparation and further 2.6% did not specify whether they are competent or not.

679 of the 704 respondents specified their potato purchase frequencies. Just 2.8% of them buy potatoes several times per week. 20.9% purchase potatoes once in a week, 35.2% fortnightly and 27.8% once in a month. 4.9% cultivate their own potatoes and did not purchase them at all. 8.4% stated that they buy potatoes within another interval. People were also asked how much potatoes they consume in their household during a month. As we assume that shopping frequency correlates with potato consumption per month, we generate a crosstab including these two variables (Table 2). Because the Pearson Chi-Square test shows high significance ($p<0.001$), these two variables can be seen as associated with each other. One half of those growing their own potatoes consume 2.5-4.9 kg potatoes per month within their household. 21.4% of them consume 5-7.4 kg in a month. The crosstab shows that the higher the potato consumption per month the more frequently potatoes were purchased.

Shop_frequ * Consume_fp Crosstabulation

			Consume_fp (in kg)							Total
			<2.5	2.5-4.9	5-7.4	7.5-9.9	10-12.4	12.5-14.9	>=15	
Shop_frequ	1	Count	3	14	6	1	3	1	0	28
		% within Shop_frequ	10.7%	50.0%	21.4%	3.6%	10.7%	3.6%	0.0%	100.0%
	2	Count	4	5	4	2	2	0	1	18
		% within Shop_frequ	22.2%	27.8%	22.2%	11.1%	11.1%	0.0%	5.6%	100.0%
	3	Count	33	72	20	11	5	0	1	142
		% within Shop_frequ	23.2%	50.7%	14.1%	7.7%	3.5%	0.0%	0.7%	100.0%
	4	Count	66	126	32	8	4	3	0	239
		% within Shop_frequ	27.6%	52.7%	13.4%	3.3%	1.7%	1.3%	0.0%	100.0%
	5	Count	72	89	13	5	7	0	2	188
		% within Shop_frequ	38.3%	47.3%	6.9%	2.7%	3.7%	0.0%	1.1%	100.0%
	6	Count	21	16	4	2	6	1	5	55
		% within Shop_frequ	38.2%	29.1%	7.3%	3.6%	10.9%	1.8%	9.1%	100.0%
Total		Count	199	322	79	29	27	5	9	670
		% within Shop_frequ	29.7%	48.1%	11.8%	4.3%	4.0%	0.7%	1.3%	100.0%

Table 2: Crosstab including potato purchase frequencies and potato consumption per household.

The size of a household also influences the potato consumption as Table 3 shows. The larger the household is the more potatoes are consumed. Pearson Chi-Square test shows high significance ($p<0.001$). The household size and the consumption of fresh potatoes are associated with each other. For examining the effect of household size on the potato consumption, we calculated the potato consumption per person. A Swiss single household consume on average 3.81 kg of potatoes per month. This per capita consumption declines continuously until a household size of 6 persons where 1.22 kg potatoes are consumed per person. Respondents who stated a household size of more than 6 people reported a per capita consumption of 1.55 kg (Table 4).

Household size * Consume_fp Crosstabulation

			Consume_fp (in kg)							Total
			<2.5	2.5-4.9	5-7.4	7.5-9.9	10-12.4	12.5-14.9	>=15	
Household size	1	Count	78	45	3	1	2	0	1	130
		% within Household size	60.0%	34.6%	2.3%	0.8%	1.5%	0.0%	0.8%	100.0%
	2	Count	84	163	34	11	8	0	4	304
		% within Household size	27.6%	53.6%	11.2%	3.6%	2.6%	0.0%	1.3%	100.0%
	3	Count	18	40	7	5	6	1	1	78
		% within Household size	23.1%	51.3%	9.0%	6.4%	7.7%	1.3%	1.3%	100.0%
	4	Count	14	53	23	9	5	2	3	109
		% within Household size	12.8%	48.6%	21.1%	8.3%	4.6%	1.8%	2.8%	100.0%
	5	Count	4	15	6	4	7	1	0	37
		% within Household size	10.8%	40.5%	16.2%	10.8%	18.9%	2.7%	0.0%	100.0%
	6	Count	0	5	6	1	0	1	0	13
		% within Household size	0.0%	38.5%	46.2%	7.7%	0.0%	7.7%	0.0%	100.0%
	7	Count	0	0	1	0	2	0	0	3
		% within Household size	0.0%	0.0%	33.3%	0.0%	66.7%	0.0%	0.0%	100.0%
Total		Count	198	321	80	31	30	5	9	674
		% within Household size	29.4%	47.6%	11.9%	4.6%	4.5%	0.7%	1.3%	100.0%

Table 3: Crosstab including household size and potato consumption per household.

Descriptive Statistics[a]

Household size		N	Minimum	Maximum	Mean	Std. Deviation
1	Consume_p_P	130	2.50	17.50	3.8077	2.18379
	Valid N (listwise)	130				
2	Consume_p_P	304	1.25	8.75	2.5658	1.31073
	Valid N (listwise)	304				
3	Consume_p_P	78	.83	5.83	1.9444	1.08833
	Valid N (listwise)	78				
4	Consume_p_P	109	.63	4.38	1.6227	.82073
	Valid N (listwise)	109				
5	Consume_p_P	37	.50	3.00	1.4730	.70658
	Valid N (listwise)	37				
6	Consume_p_P	13	.83	2.50	1.2179	.46465
	Valid N (listwise)	13				
7	Consume_p_P	3	1.07	1.79	1.5476	.41239
	Valid N (listwise)	3				

a. No statistics are computed for one or more split files because there are no valid cases.

Table 4: Per capita potato consumption as a function of the household size.

Household potato losses

Within the survey, participants should give a rough estimate on several loss rates. They estimated the amount of fresh potatoes respectively chips which is being disposed without being prepared, for example because fresh potatoes sprout while storage or because chips in an open bag are not tasty anymore. On average, people estimate these losses for fresh potatoes to be 8.48% (s=9.10) and for chips 4.18% (s=9.40). More than one third of the participants (36.4%) stated that they have no fresh potato losses at all while even 73.3% specify that they have 0% chips losses due do that reasons.

Participants should also estimate their peeling and preparation losses and their leftovers of fresh potatoes and of processed potato products. On average, people estimated their peeling and preparation losses to be 7.10% (s=4.12) of the initial fresh potato amount. 3.06% (s=4.48) respectively 3.29% (s=5.09) of the initial amounts are disposed as leftovers of fresh potatoes respectively processed potato products. For both questions about the leftovers, 58% responded that they do not have any leftovers at all. More than one quarter (26.9%) estimated their leftovers in both cases to be 5%.

The results of the diary study are different for the peeling and preparation losses and the leftovers. In the diary study 13.08% (s=5.34) of the initial amount of fresh potatoes are rejected due to peeling and preparation. This seems reliable as people weighted the peelings. The diary results for the leftovers are lower than the survey results. Just 0.81% (s=2.97) leftovers occur for fresh potatoes and just 1.1% (s=2.83) for potato products. These leftovers just contain the share being disposed. If we also include the leftovers which will be eaten during another meal, we calculate 14.12% (s=12.30) of the initial fresh potato amount. But finally, according to the diary, more than 90% (M=90.58%; s=24.85) of them will be consumed later while 4.05% (s=16.68) of these total leftovers will be fed to animals and 5.37% (s=18.99) will be disposed in the residual waste. Table 5 shows the loss rates of the survey and those of the diary.

		Survey results of participants who just answered the survey			Survey results of diary participants			Diary results		
	Unit	N	M	s	N	M	s	N	M	s
Fresh potatoes										
Raw potato losses	%	616	8.64	9.31	66	6.97	6.79	-	-	-
Peeling and preparation losses	%	597	7.05	4.08	66	7.5	4.49	67	13.08	5.34
Leftovers after cooking	%	502	3.18	4.61	55	2	2.82	67	0.81	2.97
Processed potatoes										
Leftovers	%	554	3.34	4.94	64	2.89	6.29	28	1.1	2.83
Chips	%	558	4.44	9.73	61	1.8	5	-	-	-

Table 5: Comparison of loss rates for different samples.

People might be influenced by monitoring the leftovers in a diary and tend to eat their leftovers in subsequent meals rather than declaring them as leftovers in the diary. That is why we decided to use the loss rates gained by the survey except of the peeling and preparation losses for the calculation of total losses. This particular loss rate results from diary data. In total, 23.28% of all fresh potatoes bought by Swiss private households are on average lost during a month. For processed potato products this total loss rate is much lower because they result to one fifth out of chips losses and to four fifth out of leftovers which will be disposed.

3.56% of all potato products purchased by Swiss households are on average thrown away during a month.

The household consumption of potatoes per month was also linked to the total losses. Households consuming less potatoes have higher loss rates than households consuming more (Table 6). Households which consume less than 2.5 kg per month have an average loss rate of 20.59% whereas households consuming 10-12.4 kg per month just dispose 14.32% of the initial potato amount.

Descriptive Statistics

Consume_fp		N	Minimum	Maximum	Mean	Std. Deviation
1	Total potato losses	152	0	80	20.59	14.794
2	Total potato losses	260	0	75	18.96	12.623
3	Total potato losses	67	0	100	19.93	15.063
4	Total potato losses	27	5	55	19.44	12.352
5	Total potato losses	22	5	40	14.32	9.167
6	Total potato losses	3	10	20	15.00	5.000
7	Total potato losses	5	5	20	13.00	5.701
9999	Total potato losses	8	0	25	13.13	7.990

Table 6: Total household potato losses as a function of the potato consumption.

Potato storage behavior

Consumers were also asked about their storing habits. Multiple answers were possible. 16.8% of the participants responded, that they store their potatoes in cold atmosphere (below 7°C). 39.1% store them cool (8°C-15°C) and 23.9% of the sample shelve fresh potatoes by room temperature. 62.2% of the participants camp potatoes in the dark, 4.3% stated that they store them brightly. Furthermore, people should specify if they shelve fresh potatoes in their packaging or if they unpack them before storage. 27.8% of the participants did the latter, while 35.9% leave potatoes in their package. 4.3% stated that they do not store potatoes at all.

According to these specifications, we analyzed how many people store fresh potatoes in a completely proper way and how many do not. Therefore, we defined that the best storage conditions would be cool (8°C-15°C), dark and unpacked. Just 96 out of 704 (13.6%) respondents shelve their potatoes exactly according to these conditions. 29.7% fulfill two out of these three conditions and further 33.1% fulfill just one of these criterions while storing potatoes. 166 people (23.6%) do neither store potatoes cool, nor dark, nor unpacked.

Assuming that proper storing behavior correlate with the age of the participants, we calculated Pearson correlation coefficient. It shows that the age of the participants correlates significantly ($r=0.101$; $p=0.008$) with sustainable storage habits. Table 7 shows the crosstab of the age group and the extent of proper storing behavior. Only 18.1% of the youngest age

group (20-39) did two out of three conditions in a proper way while 32.7% of the oldest group (80-99) did so. Pearson Chi-Square test shows significance on a α=10% scale (p=0.63).

Age * Good_Storage Crosstabulation

			Good_Storage				Total
			0	1	2	3	
Age	2	Count	26	35	15	7	83
		% within Age	31.3%	42.2%	18.1%	8.4%	100.0%
		Std. Residual	1.5	1.4	-2.0	-1.3	
	3	Count	71	94	89	40	294
		% within Age	24.1%	32.0%	30.3%	13.6%	100.0%
		Std. Residual	.4	-.4	.1	.0	
	4	Count	55	80	85	41	261
		% within Age	21.1%	30.7%	32.6%	15.7%	100.0%
		Std. Residual	-.7	-.8	.8	1.0	
	5	Count	7	21	16	5	49
		% within Age	14.3%	42.9%	32.7%	10.2%	100.0%
		Std. Residual	-1.3	1.1	.4	-.6	
Total		Count	159	230	205	93	687
		% within Age	23.1%	33.5%	29.8%	13.5%	100.0%

Table 7: Crosstab including the age of participants and the extent of proper storing behavior.

To find out more about consumers' storing behavior, we asked where people store their fresh potatoes. Nearly one half (45.0%) of the respondents stated that they camp their potatoes in the cellar. 23.7% put them in the store cupboard respectively the pantry. 18.9% put their fresh potatoes in a fridge and 6.1% use the kitchen cabinet to stock them.

Potato purchase behavior

Nearly three-fourth (72.0%) purchase potatoes through the retail industry, one eighth (12.4%) directly at farm stores. Only 5.9% of all participants buy potatoes in the market place and 5.2% grow their own potatoes. The remaining 4.4% buy them somewhere else.

In Switzerland, consumers basically have the choice between three quality levels: The highest so called premium quality includes mostly specialties. They are usually bought in a precious package like a wooden basket and in small amounts. Only 39 out of 631 (6.2%) participants usually purchase premium potatoes. The majority of the respondents (89.9%) buy standard quality which possesses a common potato package. Just 4.0% of the respondents purchase the so-called basic quality, which is usually cheaper and potatoes are not brushed.

People were also asked whether they purchase organic potatoes. Only 39 out of 663 (5.9%) solely buy and further 7.5% mostly buy organic potatoes. 38.9% purchase organic potatoes partly while 15.1% do mostly not buy them. Nearly one third (32.6%) never buys organic fresh potatoes.

We are also investigating the losses of processed potato products in Swiss households. Therefore, we need to know which potato products are usually bought by these consumers. 274 out of the 704 participants purchase chips at least once in a month. During the same period, 21.6% stated that they buy French fries, 16.5% fried grated potatoes, 24.7% mashed potatoes, 9.9% croquette and 6.4% purchase other processed potato products.

Potato disposal behavior

People were also asked what they do with their peeling and preparation losses respectively their leftovers. Nearly one quarter (24.5%) of the answering 669 people dispose peeling and preparation losses within their residual waste. 71.6% put these losses to the organic waste respectively compost. Further 2.8% feed them to animals while the remaining 1.0% use different disposal procedures for their peeling and preparation losses.

Completely different are the disposal procedures for leftovers. 80.8% of the 625 respondents stated that they eat leftovers during the next meals. Just 6.7% dispose them in the residual waste und 7.6% use the organic waste respectively the compost for their leftovers. 3.0% feed them to animals while 1.8% dispose leftovers differently.

Participants were also asked what they do with green respectively stained potatoes. They could decide whether they eat green or stained potatoes completely, or if they cut the green/stained spots out of the potato and eat the remaining part, or if they dispose the potato completely. For green tubers, 83.0% of the 687 respondents cut the bad part out of the tuber and eat the remaining part. 91.5% do so with stained potatoes. 7.6% (green) respectively 5.2% (stained) eat these potatoes completely withal these damages. 9.5% throw green tubers completely away while 3.2% do so with stained potatoes.

Consumer preferences for potatoes

Beside these factors concerning consumers' behavior, participants were also asked for their preferences. Therefore, they could choose multiply from a list with attributes according to the importance of the particular attribute. The first attribute was the packing date. 10.8% of the 705 participants mind the packing date while buying potatoes. 21.2% are looking for unpacked potatoes. 81.0% take care of the cooking characteristics (floury vs. waxy), 34.3% take care of the breed, 42.5% for the origin of the potatoes and 18.2% take care whether the tubers are organic. Just 29.5% of the sample stated that they mind the general conditions (green tubers, soil, shape, color, stains) of the potatoes and even fewer (15.3%) stated that they watch the price.

To find out the consumers' preferences, they could rate several characteristics on a scale from -2 (unimportant) to 2 (very important). The Mean and the St. Deviation of each aspect across the sample is shown by Figure 4. The cooking characteristics seem to be the most important factor for consumers. They rate their importance while buying potatoes on average to 1.40. The origin of the potatoes is also important for consumers (M=0.96). The most unimportant criterion is "no deformities" which is rated with -0.94 followed by "no small tubers" (M=-0.74). On average, people seem to be neutral about the price (M=0.07) and the method of production (organic vs. conventional) (M=-0.08).

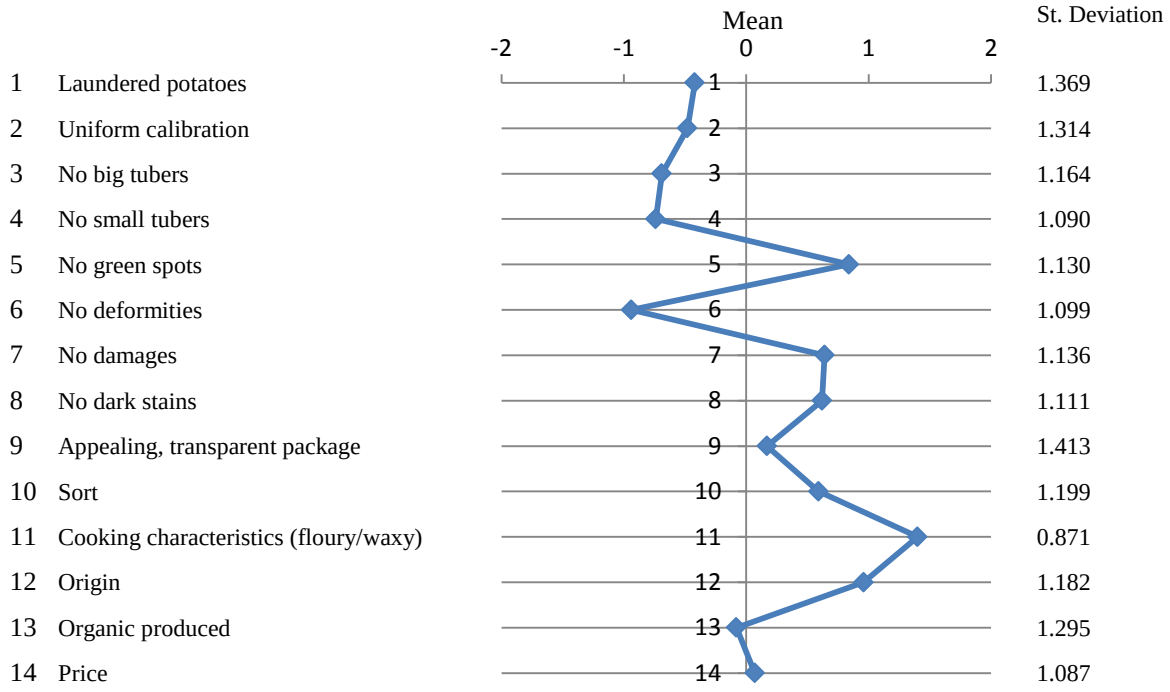

Figure 4: Consumers' preferences on 14 different aspects. Participants were asked how important these aspects are while purchasing potatoes. They could rate from -2 (unimportant) to 2 (important).

Factor analysis

A factor analysis was conducted to reduce the dimensions of consumer preferences to underlying factors. Therefore, all variables shown in Figure 4 were included in the factor analysis except the variable "price", which represent a particular factor that should not be merged with one of the other variables for the ongoing research. Table 8 shows the variables' factor loadings. Four factors have been extracted which all have a higher Eigenvalue than 1. 61.6% of the total variance can be explained by these four components.

Each variable is clustered to that component where the factor loading indicates the highest absolute value. Table 9 shows the variables which have been assigned to each component and the names that have been given to these components according to the variables being

contained. The variables within a component fit in some way to each other. For each dataset, SPSS calculates a factor values for each of the four components. These factor values can be integrated as variables in further data analysis.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Laundered potatoes	.407	.197	.233	-.237
Uniform calibration	.776	.124	.125	-.008
No big tubers	.865	.154	.026	.068
No small tubers	.839	.057	.023	.025
No green spots	.162	.739	.068	.119
No deformities	.587	.389	.026	-.101
No damages	.138	.844	.101	.025
No dark stains	.187	.849	.053	-.056
Appealing, transparent package	.294	.250	.393	-.349
Sort	.132	.125	.711	.264
Cooking characteristics (floury/waxy)	.005	.004	.836	.086
Origin	-.041	.080	.225	.765
Organic produced	.032	.028	.060	.767

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Table 8: Rotated component matrix of the 13 variables focusing on consumers' preferences.

Component	Variables	Name
1	Laundered potatoes; Uniform calibration; No big tubers; No small tubers; No deformities	Appearance
2	No green spots; No damages; No dark stains	Qualitative scarcities
3	Appealing, transparent package; Breed; Cooking characteristics (floury/waxy)	Treatment
4	Origin; Organic produced	Origin

Table 9: Extracted components, the variables assigning to each component and the name of these components.

Generalized Linear Models (GLM)

Determinants of pouch losses

To examine the effects of several predictors on the dependent variable "pouch losses" we conducted a negative binomial regression analysis. Table 10 shows the predictors for this analysis. Next to socio-demographic factors which may influence the household potato waste according to Canali et al. (2014) we included behavioral variables like the shopping frequency of fresh potatoes or the amount of potatoes that is being consumed or if losses are fed to animals. Furthermore, we included variables which base on consumer preferences. The four factors resulting from the factor analysis (appearance, qualitative scarcities, treatment, origin) are included to the regression as well as preferences according to the price, the quality standard or organic potatoes.

Variable	Description	Coding
Household size	Number of persons living in the household	1=1 person; 2=2 persons; 3=3 persons; 4=4 persons; 5=5 persons; 6=6 persons; 7=>6 persons
Minor	Number of minor living in the household	0=0 minor; 1=1 minor; 2=2 minors; 3=3 minors; 4=4 minors; 5=5 minors; 6=>5 minors
Meals/week	Count of meals per week	1=1 meal; 2=2 meals; 3=3 meals; 4=4 meals; 5=5 meals; 6=6 meals; 7=7 meals; 8=8 meals; 9=9 meals; 10=10 meals; 11=>10 meals
Persons/meal	Count of persons usually participating a meal	1=1 person; 2=2 persons; 3=3 persons; 4= 4 persons; 5=5 persons; 6=6 persons; 7=>6 persons
Education	Educational level of the participant	0=None; 1=compulsory school; 2=university entrance diploma; 3=professional education; 4=vocational school diploma ;5=Master craftsman; 6=college of higher education; 7=university; 8=differently
Income	Net income of the whole household per month	1=<3000CHF; 2=3'001-5'000CHF; 3=5'001-7'000CHF; 4=7'001-9'000CHF; 5=9'001-11'000CHF; 6=11'001-13'000CHF; 7=13'001-15'000CHF; 8=>15'000CHF
Sex	Sex of the participant	0=female; 1=male
Age	Age-group of the participant	1=0-19 years old; 2=20-39 years old; 3=40-59 years old; 4=60-79 years old; 5=80-99 years old
Shop_frequ	Shopping frequency of fresh potatoes	1=never; 2=several times a week; 3=once a week; 4=fortnightly; 5=once a month; 6=differently
Consume_fp	Consume of fresh potatoes during a month	1=<2.5kg; 2=2.5-4.9kg; 3=5-7.4kg; 4=7.5-9.9kg; 5=10-12.4kg; 6=12.5-15kg; 7=>15kg
Good_Storage	Rating of storage conditions as the count of conditions that are good for potato storage (cool atmosphere, dark, unpacked)	0=do nothing right; 1=do one thing right; 2=do two things right; 3=all three good storage conditions are fulfilled
Peelings_animals	Are peeling and preparations losses fed to animals	0=no; 1=yes
P_Price	Is the price important for you by purchasing fresh potatoes	-2=highly unimportant; -1=mostly unimportant; 0=indifferent; 1=mostly important; 2=highly important
Q_Standard	Do you buy potatoes in standard quality?	0=no; 1=yes
Organic	Do you buy organic potatoes	1=solely; 2=solely-partly; 3=partly; 4=partly-never; 5=never
Appearance	Created factor from factor analysis	
Qualitative scarcities	Created factor from factor analysis	
Treatment	Created factor from factor analysis	
Origin	Created factor from factor analysis	

Table 10: Variables included into the regression for pouch losses.

Several tests certify the goodness of fit of the negative binomial regression. Pearson Chi-Square is calculated to be 317.461 by 342 df. This value, divided by df should be close to 1 to indicate a good fit of the model. For our data we get 0.928 which indicates a good fit of the model. To compare the fitted model against the intercept-only model, an Omnibus test is conducted. The Likelihood Ratio Chi-Square is 110.056 by 58 df ($p<0.001$) which indicates high significance of the fitted model. Table 11 shows the model effects of the particular predictors on the pouch losses of fresh potatoes.

Tests of Model Effects

Source	Type III		
	Likelihood Ratio Chi-Square	df	Sig.
(Intercept)	13.971	1	.000***
Household size	5.263	6	.511
Minor	4.526	4	.339
Meals/week	16.740	10	.080*
Education	8.827	7	.265
Income	4.177	7	.759
Sex	2.054	1	.152
Age	13.963	3	.003***
Shop_frequ	5.382	3	.146
Organic	8.439	4	.077*
Good_Storage	7.186	3	.066*
Q_Standard	1.448	1	.229
Peelings_animals	6.659	1	.010***
Appearance	10.743	1	.001***
Qualitative scarcities	2.718	1	.099*
Treatment	4.437	1	.035**
Origin	.448	1	.503
P_Price	2.266	4	.687

Dependent Variable: Pouch losses
***significant at 1%; **significant at 5%; *significant at 10%

Table 11: Regression analysis results for the tested predictors for pouch losses of fresh potatoes.

Table 11 shows that from all socio-demographic factors, just the amount of meals per week (p=0.08) and the age (p=0.003) have a significant impact on pouch losses of fresh potatoes. Regarding consumers' behavior, the preference for organic produced potatoes (p=0.077) and the extent of proper storage habits (p=0.066) influence pouch losses significantly as well as the existence of pets (p=0.010). Furthermore, three of the predictors considering consumers' preferences show a significant impact on pouch losses: Appearance (p=0.001), qualitative scarcities (p=0.099) and treatment (p=0.035). Table 12 to Table 14 contain the parameter estimates for the model. The B values in these three tables indicate whether an effect is positive or negative. This means that consumers who prefer a perfect appearance and the absence of qualitative scarcities have higher pouch losses (positive B values). The more important the treatment (cooking behavior, breed, packaging) is, the lower pouch losses are (negative B value). The Exp(B) value indicates the extent of the effect in comparison to a reference situation. For example people who do not feed their peeling and preparation losses to pets have higher pouch losses (positive B value). The Exp(B) value shows that the pouch loss rate is 4.495 times higher than those who usually feed their peeling and preparation losses to animals, holding the other variables constant. The estimate of the dispersion coefficient (Negative binomial) is fixed at 1 which indicates over-dispersion.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
(Intercept)	-1.834	1.4169	-4.611	.943	1.675	1	.196	.160
[Household size =1]	.976	.8821	-.753	2.705	1.225	1	.268	2.655
[Household size =2]	.774	.8703	-.932	2.480	.791	1	.374	2.168
[Household size =3]	.916	.8572	-.764	2.596	1.143	1	.285	2.500
[Household size =4]	.866	.8501	-.801	2.532	1.037	1	.309	2.376
[Household size =5]	.411	.9514	-1.454	2.276	.187	1	.666	1.508
[Household size =6]	1.509	.9846	-.421	3.438	2.347	1	.125	4.520
[Household size =7]	0[a]							1
[Minor =0]	.905	.9065	-.872	2.682	.997	1	.318	2.472
[Minor =1]	1.103	.8728	-.608	2.813	1.596	1	.206	3.012
[Minor =2]	.833	.8882	-.908	2.574	.880	1	.348	2.301
[Minor =3]	1.776	1.0195	-.223	3.774	3.033	1	.082*	5.903
[Minor =4]	0[a]							1
[Meals/week =1]	1.175	.5039	.187	2.162	5.435	1	.020**	3.237
[Meals/week =2]	.312	.4326	-.535	1.160	.522	1	.470	1.367
[Meals/week =3]	-.271	.4394	-1.132	.590	.380	1	.538	.763
[Meals/week =4]	-.182	.3182	-.805	.442	.326	1	.568	.834
[Meals/week =5]	.372	.2849	-.186	.930	1.704	1	.192	1.451
[Meals/week =6]	.306	.2871	-.257	.868	1.133	1	.287	1.358
[Meals/week =7]	-.049	.2356	-.511	.412	.044	1	.835	.952
[Meals/week =8]	.175	.3765	-.562	.913	.217	1	.641	1.192
[Meals/week =9]	.174	.3363	-.485	.833	.268	1	.605	1.190
[Meals/week =10]	.027	.3029	-.567	.621	.008	1	.929	1.028
[Meals/week =11]	0[a]							1
[Education =0]	.283	.6936	-1.076	1.643	.167	1	.683	1.328
[Education =1]	.027	.2398	-.443	.497	.012	1	.912	1.027
[Education =2]	-.556	.3189	-1.181	.069	3.040	1	.081*	.573
[Education =3]	.040	.2324	-.415	.496	.030	1	.862	1.041
[Education =4]	.657	.4159	-.158	1.472	2.493	1	.114	1.928
[Education =5]	.199	.2706	-.331	.729	.542	1	.462	1.220
[Education =6]	.141	.2382	-.326	.608	.350	1	.554	1.151
[Education =7]	0[a]							1
[Income=1]	.049	.3701	-.676	.774	.018	1	.894	1.050
[Income =2]	.173	.3042	-.423	.769	.324	1	.569	1.189
[Income =3]	.144	.2788	-.402	.691	.267	1	.605	1.155
[Income =4]	.001	.2709	-.529	.532	.000	1	.996	1.001
[Income =5]	.157	.2772	-.386	.700	.322	1	.571	1.170
[Income =6]	-.322	.3452	-.999	.354	.872	1	.350	.724
[Income =7]	.323	.3785	-.419	1.064	.726	1	.394	1.381
[Income =8]	0[a]							1
[Sex=1]	-.201	.1413	-.478	.076	2.025	1	.155	.818
[Sex=2]	0[a]							1
[Age=2]	.650	.3335	-.003	1.304	3.803	1	.051*	1.916
[Age=3]	.476	.3065	-.125	1.076	2.408	1	.121	1.609
[Age=4]	-.042	.2913	-.613	.529	.021	1	.886	.959
[Age=5]	0[a]							1

Table 12: Socio-demographic parameter estimates of regression analysis for pouch losses.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
[Shop_frequ =2]	.069	.3796	-.675	.813	.033	1	.855	1.072
[Shop_frequ =3]	-.329	.1607	-.644	-.014	4.187	1	.041**	.720
[Shop_frequ =4]	.020	.1421	-.259	.298	.019	1	.890	1.020
[Shop_frequ =5]	0[a]							1
[Organic =1]	-.014	.3448	-.690	.662	.002	1	.968	.986
[Organic =2]	.519	.2439	.041	.997	4.524	1	.033**	1.680
[Organic=3]	.343	.1540	.042	.645	4.971	1	.026**	1.410
[Organic =4]	.163	.1829	-.195	.522	.799	1	.371	1.178
[Organic =5]	0[a]							1
[Good_Storage =0]	.266	.2237	-.172	.705	1.418	1	.234	1.305
[Good_Storage =1]	-.137	.2138	-.556	.282	.411	1	.522	.872
[Good_Storage =2]	.080	.2222	-.356	.515	.128	1	.721	1.083
[Good_Storage =3]	0[a]							1
[Q_Standard=0]	.252	.2133	-.166	.670	1.395	1	.238	1.287
[Q_Standard=1]	0[a]							1
[Peelings_animals =0]	1.503	.5557	.414	2.592	7.316	1	.007***	4.495
[Peelings_animals =1]	0[a]							1

Table 13: Behavioral parameter estimates of regression analysis for pouch losses.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
Appearance	.227	.0694	.091	.363	10.694	1	.001***	1.255
Qualitative scarcities	.109	.0660	-.020	.239	2.747	1	.097*	1.116
Treatment	-.137	.0659	-.266	-.008	4.352	1	.037**	.872
Origin	-.051	.0760	-.200	.098	.448	1	.503	.950
[P_Price=-2]	-.118	.2969	-.700	.464	.158	1	.691	.889
[P_Price=-1]	-.048	.2917	-.620	.524	.027	1	.869	.953
[P_Price=0]	.142	.2553	-.359	.642	.308	1	.579	1.152
[P_Price=1]	.020	.2731	-.515	.555	.005	1	.941	1.020
[P_Price=2]	0[a]							1
(Scale)	1[b]							
(Negative binomial)	1[b]							

Dependent Variable: Pouch losses

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Table 14: Estimates for parameters representing consumer preferences from regression analysis for pouch losses.

Determinants of peeling and preparation losses

To examine the influence of several predictors on the dependent variable “peeling losses” a Poisson regression was conducted. Table 15 contains the predictors which have been put in our regression model. Again, we put next to socio-demographic factors, variables considering consumer preferences and consumer behavior in our model.

Variable	Description	Coding
Household size	Number of persons living in the household	1=1 person; 2=2 persons; 3=3 persons; 4=4 persons; 5=5 persons; 6=6 persons; 7=>6 persons
Minor	Number of minor living in the household	0=0 minor; 1=1 minor; 2=2 minors; 3=3 minors; 4=4 minors; 5=5 minors; 6=>5 minors
Meals/week	Count of meals per week	1=1 meal; 2=2 meals; 3=3 meals; 4=4 meals; 5=5 meals; 6=6 meals; 7=7 meals; 8=8 meals; 9=9 meals; 10=10 meals; 11=>10 meals
Persons/meal	Count of persons usually participating a meal	1=1 person; 2=2 persons; 3=3 persons; 4= 4 persons; 5=5 persons; 6=6 persons; 7=>6 persons
Education	Educational level of the participant	0=None; 1=compulsory school; 2=university entrance diploma; 3=professional education; 4=vocational school diploma ;5=Master craftsman; 6=college of higher education; 7=university; 8=differently
Income	Net income of the whole household per month	1=<3000CHF; 2=3'001-5'000CHF; 3=5'001-7'000CHF; 4=7'001-9'000CHF; 5=9'001-11'000CHF; 6=11'001-13'000CHF; 7=13'001-15'000CHF; 8=>15'000CHF
Sex	Sex of the participant	0=female; 1=male
Age	Age-group of the participant	1=0-19 years old; 2=20-39 years old; 3=40-59 years old; 4=60-79 years old; 5=80-99 years old
Dispose_green	Dispose potatoes with green spots	0=no; 1=yes
Dispose_stains	Dispose potatoes with stains	0=no; 1=yes
Consume_fp	Consume of fresh potatoes during a month	1=<2.5kg; 2=2.5-4.9kg; 3=5-7.4kg; 4=7.5-9.9kg; 5=10-12.4kg; 6=12.5-15kg; 7=>15kg
Good_Storage	Rating of storage conditions as the count of conditions that are good for potato storage (cool atmosphere, dark, unpacked)	0=do nothing right; 1=do one thing right; 2=do two things right; 3=all three good storage conditions are fulfilled
Peelings_animals	Are peeling and preparations losses fed to animals	0=no; 1=yes
Peelings_waste	Dispose peelings in the residual waste	0=no; 1=yes
P_Price	Is the price important for you by purchasing fresh potatoes	-2=highly unimportant; -1=mostly unimportant; 0=indifferent; 1=mostly important; 2=highly important
Q_Standard	The quality specification of the potatoes	1=Premium; 2=Standard; 3=Basic
Organic	Do you buy organic potatoes	1=solely; 2=solely-partly; 3=partly; 4=partly-never; 5=never
Appearance	Created factor from factor analysis	
Qualitative scarcities	Created factor from factor analysis	
Treatment	Created factor from factor analysis	
Origin	Created factor from factor analysis	

Table 15: Variables included into the regression for peeling and preparation losses.

As well as for the negative binomial regression, several tests indicate the goodness of fit of our generalized linear model with the Poisson probability distribution. Pearson Chi-Square results in 711.734 by 369 df. The quotient out of these two values is below 2 (1.929) which indicates an overall acceptable fit of the model. The Omnibus test for the comparison of the fitted model against the intercept-only model is significant ($p<0.001$). Table 16 shows the model effects of the particular predictors. From all socio-demographic variables, the number of minors within the household is significant as well as the number of meals per week, the educational level, the income and the age. Regarding consumer behavior, only the feeding of

peeling to pets has a significant effect on peeling losses. Furthermore, just one factor concerning consumer preferences (appearance of potatoes) has an effect on the dependent variable.

Tests of Model Effects

Source	Type III		
	Likelihood Ratio Chi-Square	df	Sig.
(Intercept)	97.895	1	.000***
Household size	3.291	5	.655
Minor	24.553	5	.000***
Meals/week	38.499	10	.000***
Persons/meal	6.466	5	.264
Education	15.602	7	.029**
Income	13.723	7	.056*
Sex	.040	1	.841
Age	6.723	3	.081*
Good_Storage	4.659	3	.199
Consume_fp	8.870	6	.181
Organic	5.042	4	.283
Dispose_stains	.297	1	.586
Dispose_green	.106	1	.745
Peelings_animals	7.448	1	.006***
Peelings_waste	1.594	1	.207
P_Price	3.620	4	.460
Q_Standard	.694	2	.707
Appearance	9.469	1	.002***
Qualitative scarcities	.012	1	.913
Treatment	.645	1	.422
Origin	1.453	1	.228

Dependent Variable: Peeling losses
***significant at 1%; **significant at 5%; *significant at 10%

Table 16: Regression analysis results for the tested predictors for peeling losses of fresh potatoes.

The parameter estimates are shown in Table 17 to Table 19. Again, we can see to which direction an effect appears. The positive B value (0.065) for the appearance of the potatoes indicates that the more important the appearance of the potatoes is, the higher the peeling and preparation losses are. Regarding education we see that more or less all types of educational degrees have lower peeling losses as those who have a university diploma. Just people who do not have any educational achievement have higher peeling losses. The age also plays an important role. The loss rate of people aged between 20 and 39 is 1.264 times higher than those aged between 80 and 99. In general, younger people tend to have higher peeling and preparation losses. Also consumer behaviors play a major role. People who do not feed peeling and preparation losses to pets have lower peeling losses than those who do.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
(Intercept)	1.092	.6403	-.163	2.347	2.906	1	.088*	2.979
[Household size =1]	.299	.5109	-.703	1.300	.342	1	.559	1.348
[Household size =2]	.234	.4956	-.737	1.205	.223	1	.637	1.264
[Household size =3]	.152	.4865	-.802	1.105	.097	1	.755	1.164
[Household size =4]	.135	.4770	-.800	1.070	.080	1	.778	1.144
[Household size =5]	.096	.4759	-.837	1.028	.040	1	.841	1.100
[Household size =6]	.447	.4261	-.388	1.282	1.103	1	.294	1.564
[Household size =7]	0[a]							1
[Minor=0]	.371	.4592	-.529	1.271	.654	1	.419	1.450
[Minor =1]	.609	.4654	-.303	1.522	1.715	1	.190	1.839
[Minor =2]	.771	.4708	-.151	1.694	2.684	1	.101	2.163
[Minor =3]	.720	.4916	-.243	1.684	2.147	1	.143	2.055
[Minor =4]	.148	.5518	-.933	1.230	.072	1	.788	1.160
[Minor =6]	0[a]							1
[Meals/week =1]	.432	.1632	.112	.752	7.007	1	.008***	1.540
[Meals/week =2]	-.187	.1527	-.486	.113	1.492	1	.222	.830
[Meals/week =3]	.090	.1287	-.162	.342	.492	1	.483	1.094
[Meals/week =4]	.082	.1046	-.123	.287	.617	1	.432	1.086
[Meals/week =5]	-.203	.0971	-.393	-.013	4.378	1	.036**	.816
[Meals/week =6]	.043	.0926	-.139	.224	.214	1	.644	1.044
[Meals/week =7]	.026	.0747	-.120	.173	.126	1	.723	1.027
[Meals/week =8]	.290	.1187	.058	.523	5.984	1	.014**	1.337
[Meals/week =9]	.121	.1099	-.095	.336	1.204	1	.272	1.128
[Meals/week =10]	-.172	.0923	-.353	.009	3.467	1	.063*	.842
[Meals/week =11]	0[a]							1
[Education =0]	.451	.2660	-.071	.972	2.870	1	.090*	1.569
[Education =1]	-.199	.0776	-.351	-.047	6.571	1	.010**	.820
[Education =2]	.003	.0985	-.190	.196	.001	1	.977	1.003
[Education =3]	-.137	.0731	-.280	.007	3.494	1	.062*	.872
[Education =4]	-.189	.1422	-.468	.090	1.769	1	.184	.828
[Education =5]	-.196	.0836	-.360	-.032	5.480	1	.019**	.822
[Education =6]	-.140	.0780	-.293	.013	3.238	1	.072*	.869
[Education =7]	0[a]							1
[Income=1]	-.064	.1259	-.311	.183	.259	1	.611	.938
[Income =2]	.133	.1000	-.063	.329	1.760	1	.185	1.142
[Income =3]	.098	.0929	-.084	.280	1.124	1	.289	1.103
[Income =4]	.215	.0877	.043	.387	6.031	1	.014**	1.240
[Income =5]	.143	.0923	-.038	.324	2.404	1	.121	1.154
[Income =6]	.083	.1135	-.140	.305	.530	1	.466	1.086
[Income =7]	.182	.1180	-.049	.413	2.374	1	.123	1.199
[Income =8]	0[a]							1
[Sex =1]	-.009	.0447	-.097	.079	.040	1	.841	.991
[Sex=2]	0[a]							1
[Age=2]	.234	.1119	.015	.454	4.392	1	.036**	1.264
[Age=3]	.214	.1028	.012	.415	4.321	1	.038**	1.238
[Age=4]	.117	.0993	-.078	.311	1.376	1	.241	1.124
[Age=5]	0[a]							1

Table 17: Socio-demographic parameter estimates of regression analysis for peeling losses.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
[Good_Storage =0]	-.052	.0731	-.195	.091	.504	1	.478	.949
[Good_Storage =1]	-.005	.0665	-.135	.125	.006	1	.939	.995
[Good_Storage =2]	.063	.0669	-.068	.194	.890	1	.345	1.065
[Good_Storage =3]	0[a]							1
[Consume_fp =1]	-.112	.1795	-.463	.240	.386	1	.534	.894
[Consume_fp =2]	.017	.1752	-.327	.360	.009	1	.924	1.017
[Consume_fp =3]	.045	.1798	-.308	.397	.061	1	.804	1.046
[Consume_fp =4]	-.027	.1929	-.405	.351	.020	1	.887	.973
[Consume_fp =5]	-.141	.2206	-.574	.291	.411	1	.521	.868
[Consume_fp =6]	-.009	.3001	-.597	.579	.001	1	.976	.991
[Consume_fp =7]	0[a]							1
[Organic=1]	.121	.1068	-.088	.330	1.281	1	.258	1.128
[Organic =2]	.137	.0821	-.024	.298	2.775	1	.096*	1.147
[Organic =3]	.109	.0518	.008	.210	4.435	1	.035**	1.115
[Organic =4]	.049	.0611	-.070	.169	.654	1	.419	1.051
[Organic =5]	0[a]							1
[Dispose_stains =0]	-.062	.1138	-.285	.161	.299	1	.584	.940
[Dispose_stains =1]	0[a]							1
[Dispose_green =0]	.023	.0701	-.115	.160	.105	1	.746	1.023
[Dispose_green =1]	0[a]							1
[Peelings_animals =0]	-.443	.1567	-.750	-.136	7.991	1	.005***	.642
[Peelings_animals =1]	0[a]							1
[Peelings_waste =0]	-.060	.0474	-.153	.033	1.602	1	.206	.942
[Q_Standard=1]	.113	.1361	-.154	.380	.688	1	.407	1.120
[Q_Standard =2]	.074	.1083	-.139	.286	.463	1	.496	1.076
[Q_Standard =3]	0[a]							1

Table 18: Behavioral parameter estimates of regression analysis for peeling losses.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
[Peelings_waste =1]	0[a]							1
[P_Price=-2]	.107	.0975	-.084	.298	1.212	1	.271	1.113
[P_Price =-1]	.003	.0967	-.186	.193	.001	1	.971	1.003
[P_Price =0]	.084	.0817	-.076	.244	1.053	1	.305	1.087
[P_Price =1]	.019	.0850	-.147	.186	.052	1	.819	1.020
[P_Price =2]	0[a]							1
Appearance	.065	.0212	.024	.107	9.441	1	.002***	1.067
Qualitative scarcities	-.002	.0208	-.043	.038	.012	1	.913	.998
Treatment	.017	.0206	-.024	.057	.643	1	.423	1.017
Root	-.031	.0255	-.081	.019	1.455	1	.228	.970
(Scale)	1[b]							

Dependent Variable: Peelin losses

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Table 19: Estimates of parameters representing consumer preferences from regression analysis for peeling losses.

Determinants of leftovers

We also estimated the influence of socio-demographic predictors, consumer preferences and behaviors on the amount of leftovers. As predictors we put all variables we got into the GLM which might have an impact on the amount of potato leftovers being disposed (Table 20).

Variable	Description	Coding
Household size	Number of persons living in the household	1=1 person; 2=2 persons; 3=3 persons; 4=4 persons; 5=5 persons; 6=6 persons; 7=>6 persons
Minor	Number of minor living in the household	0=0 minor; 1=1 minor; 2=2 minors; 3=3 minors; 4=4 minors; 5=5 minors; 6=>5 minors
Meals/week	Count of meals per week	1=1 meal; 2=2 meals; 3=3 meals; 4=4 meals; 5=5 meals; 6=6 meals; 7=7 meals; 8=8 meals; 9=9 meals; 10=10 meals; 11=>10 meals
Persons/meal	Count of persons usually participating a meal	1=1 person; 2=2 persons; 3=3 persons; 4= 4 persons; 5=5 persons; 6=6 persons; 7=>6 persons
Education	Educational level of the participant	0=None; 1=compulsory school; 2=university entrance diploma; 3=professional education; 4=vocational school diploma ;5=Master craftsman; 6=college of higher education; 7=university; 8=differently
Income	Net income of the whole household per month	1=<3000CHF; 2=3'001-5'000CHF; 3=5'001-7'000CHF; 4=7'001-9'000CHF; 5=9'001-11'000CHF; 6=11'001-13'000CHF; 7=13'001-15'000CHF; 8=>15'000CHF
Sex	Sex of the participant	0=female; 1=male
Age	Age-group of the participant	1=0-19 years old; 2=20-39 years old; 3=40-59 years old; 4=60-79 years old; 5=80-99 years old
Consume_fp	Consume of fresh potatoes during a month	1=<2.5kg; 2=2.5-4.9kg; 3=5-7.4kg; 4=7.5-9.9kg; 5=10-12.4kg; 6=12.5-15kg; 7=>15kg
Leftovers_animals	Are leftovers fed to animals?	0=no; 1=yes
Leftovers_eat	Leftovers are eaten during another meal	0=no;1=yes
P_Price	Is the price important for you by purchasing fresh potatoes	-2=highly unimportant; -1=mostly unimportant; 0=indifferent; 1=mostly important; 2=highly important
Q_Standard	The quality specification of the potatoes	1=Premium; 2=Standard; 3=Basic
Appearance	Created factor from factor analysis	
Qualitative scarcities	Created factor from factor analysis	
Treatment	Created factor from factor analysis	
Origin	Created factor from factor analysis	

Table 20: Variables included into the regression for leftovers.

The goodness of fit test indicates an overall good fit of the negative binomial regression for our data. Pearson Chi-Square is 580.104 by 344 df. The quotient resulting of these two values is with 1.686 below 2 and signalizes a good fit of the model. The Omnibus test is strongly significant ($p<0.001$) with a Likelihood-Ratio Chi-Square of 156.166 by 34 df. Table 21 shows the model effects of the predictors. Most of the socio-demographic predictors show a significant impact on leftovers. The age and sex of the people is highly significant ($p<0.001$), while the education ($p=0.012$), the income ($p=0.033$), the number of meals per week ($p=0.005$) and the number of persons per mails ($p=0.005$) also show strong significance.

Regarding the variables focusing on consumer behavior, the amount of potato consumption is strongly significant (p=0.004). If consumers eat their leftovers during another mail, their losses are lower (p=0.028). Also consumer preferences play a role. The appearance (p=0.003) and qualitative scarcities (p=0.023) seem to influence the amount of disposed leftovers. Table 22-Table 24 show the parameter estimates.

Tests of Model Effects

Source	Type III		
	Likelihood Ratio Chi-Square	df	Sig.
(Intercept)	9.897	1	.002***
Age	45.132	3	.000***
Leftovers_animals	.376	1	.539
Leftovers_eat	4.853	1	.028**
Q_Standard	1.589	1	.207
P_Price	3.803	4	.433
Education	18.022	7	.012**
Income	15.204	7	.033**
Sex	15.874	1	.000***
Household size	5.773	1	.016**
Minor	.375	1	.540
Meals/week	8.052	1	.005***
Persons/meal	8.067	1	.005***
Appearance	9.015	1	.003***
Qualitative scarcities	5.189	1	.023**
Treatment	2.106	1	.147
Origin	.024	1	.876
Consume_fp	8.409	1	.004***

Dependent Variable: Leftovers
***significant at 1%; **significant at 5%; *significant at 10%

Table 21: Regression analysis results for the tested predictors for leftovers of fresh potatoes.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
[P_Price =-2]	.571	.3479	-.110	1.253	2.697	1	.101	1.771
[P_Price =-1]	.586	.3338	-.068	1.241	3.085	1	.079*	1.797
[P_Price =0]	.561	.2959	-.019	1.141	3.596	1	.058*	1.753
[P_Price =1]	.496	.2988	-.090	1.081	2.753	1	.097*	1.642
[P_Price =2]	0[a]							1
Appearance	.228	.0759	.079	.377	9.018	1	.003***	1.256
Qualitative scarcities	.169	.0739	.024	.314	5.234	1	.022**	1.184
Treatment	.102	.0703	-.036	.240	2.116	1	.146	1.108
Origin	.012	.0748	-.135	.158	.024	1	.876	1.012
(Scale)	1[b]							
(Negative binomial)	1[b]							

Dependent Variable: Leftovers

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Table 22: Estimates of parameters representing consumer preferences from regression analysis for leftovers.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
(Intercept)	.622	.7654	-.879	2.122	.660	1	.417	1.862
[Age=2]	1.842	.4444	.971	2.713	17.185	1	.000***	6.311
[Age=3]	1.702	.4159	.887	2.517	16.758	1	.000***	5.487
[Age=4]	.691	.3991	-.091	1.473	2.999	1	.083*	1.996
[Age=5]	0[a]							1
[Education =0]	-.903	.7681	-2.408	.603	1.381	1	.240	.405
[Education =1]	-.426	.2707	-.956	.105	2.472	1	.116	.653
[Education =2]	.265	.3217	-.366	.896	.679	1	.410	1.304
[Education =3]	-.245	.2450	-.725	.236	.997	1	.318	.783
[Education =4]	-1.743	.6728	-3.061	-.424	6.710	1	.010**	.175
[Education =5]	-.560	.2878	-1.124	.004	3.788	1	.052*	.571
[Education =6]	-.632	.2838	-1.188	-.075	4.953	1	.026**	.532
[Education =7]	0[a]							1
[Income=1]	.395	.4132	-.415	1.205	.914	1	.339	1.484
[Income =2]	.607	.3118	-.004	1.218	3.792	1	.052*	1.835
[Income =3]	.222	.2933	-.353	.797	.572	1	.449	1.248
[Income =4]	-.187	.2786	-.733	.359	.452	1	.501	.829
[Income =5]	.438	.2945	-.139	1.015	2.214	1	.137	1.550
[Income =6]	.017	.3719	-.712	.746	.002	1	.963	1.018
[Income =7]	.290	.4052	-.505	1.084	.511	1	.475	1.336
[Income =8]	0[a]							1
[Sex=1]	-.616	.1577	-.925	-.307	15.269	1	.000***	.540
[Sex=2]	0[a]							1
Household size	-.417	.1735	-.757	-.077	5.785	1	.016**	.659
Minor	.068	.1112	-.150	.286	.374	1	.541	1.070
Meals/week	-.092	.0327	-.156	-.028	7.918	1	.005***	.912
Persons/meal	.511	.1805	.157	.864	8.003	1	.005***	1.666

Table 23: Socio-demographic parameter estimates of regression analysis for leftovers.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)
			Lower	Upper	Wald Chi-Square	df	Sig.	
[Leftovers_animals =0]	-.243	.4023	-1.032	.545	.366	1	.545	.784
[Leftovers_animals =1]	0[a]							1
[Leftovers_eat =0]	.364	.1675	.035	.692	4.711	1	.030**	1.439
[Leftovers_eat =1]	0[a]							1
[Q_Standard=0]	.272	.2187	-.156	.701	1.549	1	.213	1.313
[Q_Standard=1]	0[a]							1
Consume_fp	-.216	.0746	-.363	-.070	8.416	1	.004***	.805

Table 24: Behavioral parameter estimates of regression analysis for leftovers.

The influence of the age on the amount of leftovers seems to be huge. People aged between 20 and 39 have 6.311 times more leftovers than 80-99 years old people. People between the

age 40 to 59 still have 5.487 times more leftovers than the oldest group. People holding a university diploma seems to have the highest losses, while all other educational levels with significant differences have lower leftover losses. Women also have less leftovers than men (Exp(B)=0.540) and bigger households have less losses than smaller ones (Exp(B)=0.659). The more meals per week are prepared, the lower the losses are (Exp(B)=0.912) but the more persons participate the meals, the higher the losses are (Exp(B)=1.666). If people consume more potatoes, the leftover losses decrease (Exp(B)=0.805) and those who do not usually eat their leftovers during another meal have 1.439 times more losses than those who do. If the appearance and the absence of qualitative scarcities are important, people have significantly 1.256, respectively 1.108 times more losses.

Discussion

A broad variety of methods is known to estimate household food waste (Lebersorger & Schneider, 2011). Waste composition analysis (Fehr & Romão, 2001; Schneider & Obersteiner, 2007; Watanabe, 2009; WRAP, 2008), household diaries (Langley et al., 2010; Selzer et al., 2009; Wenlock et al., 1980; WRAP, 2008), analysis of statistical data about food consumption and nutrition (Hall et al., 2009; Kantor et al., 1997; Watanabe, 2009), quantitative consumer surveys (Pekcan et al., 2005; Schneider & Lebersorger, 2009) or qualitative consumer interviews (Glanz & Schneider, 2009) are the most popular ones. As our study focuses specifically on potato losses, we decided to choose a combination of a quantitative consumer survey and a household diary. These methods need some effort from the participants and might be subjective (Lebersorger & Schneider, 2011) especially in comparison to waste composite analysis which might be more objective and accurate (Langley et al., 2010) but analyzing household waste is expensive and difficult to conduct over a bigger region. Furthermore, there is no international standard on how to analyze waste (Lebersorger & Schneider, 2011). Additionally, potato waste can be disposed through many ways: residual waste, organic waste or animal feed are just three possible ways. With the aid of a survey we can additionally examine consumer behaviors and preferences as well as social-demographic variables. The diary should validate the potato loss estimates of the consumers. Møller et al. (2014) mentioned that people might be “more focused on food waste and food waste reduction in a sampling period, and might thus not provide representative data from the collection period”. Although, the topic is sensitive and participants might try to avoid food losses according to the ”social norm” habit (Møller et al., 2014).

The peeling and preparation losses reported in the diary were substantially higher than participants' estimates of these losses within the survey (7.05+-4.08 within the survey; 13.08+-5.34 within the diary). We assume that the diary results are more reliable than the survey estimates as it seems to be difficult for consumers to estimate peeling and preparation losses without weighing. From total potato losses within the household, peeling and preparation losses gained by the diary represent 52.5%. Quested and Murphy (2014) calculated peeling losses of potatoes in UK with the aid of a waste composite analysis. Due to this study, 55% of total household potato losses represent peelings and further 36% of all potato losses found within the waste, have been whole, unused potatoes. In our study, this share was 34.7%. Due to our study, total potato losses within households reach 24.9% of the purchased amount. Data especially for potato losses are rare. WWF (2014) estimate these losses for Switzerland to be 29.4%, Quested and Murphy (2014) estimate household potato losses at approximately 46% for UK. The reason why our findings are lower might be due to the chosen method (social norm, more focused on food waste during sampling period (Møller et al., 2014).

In our study, we tried to examine drivers and causes of potato losses in Swiss households. According to Canali et al. (2014) we grouped several drivers into three categories: socio-demographic factors, consumer preferences and consumer behavior. Across all three loss categories (pouch losses, peeling and preparation losses and leftovers) the age shows a significant influence on the amount of potato household waste. As no study could be find examining the causes and drivers of potato losses in households, we compare the findings with general household waste analysis for Finland. Koivupuro et al. (2012) found out that only the size of household, type of household, gender of person mainly responsible for grocery shopping, household view of potential to reduce food waste, appreciation of low food prices and respondent's view of the effect of purchasing the most appropriate package size correlate significantly with the amount of food wasted within households. The age, educational level and income do not significantly correlate with the amount of food wasted according to that study. Other studies like Wassermann and Schneider (2005) from Vienna or WRAP (2008) from UK stated that young people clearly provoke more food waste than older people. Our findings confirm that at least the age is a strong predictor on the amount of potatoes being wasted but this might be that we solely focus on potatoes. Furthermore, Koivupuro et al. (2012) found out that if a woman is mainly responsible for food shopping, losses are higher as if a man or both men and women are responsible for grocery shopping.

Our findings indicate that just for leftovers the sex plays a significant role. Female participants show fewer potato leftover losses than male ones ($p<0.001$). Canali et al. (2014) confirm that young people tend to waste more than older people and older generations may have better food skills. Again, these statements refer to household food waste in general and not specifically for household potato waste. Other studies discovered that household size and the amount of children living in a household influence the amount of food being wasted (Van Garde & Woodburn, 1987; Wenlock et al., 1980). This is also valid for the potato leftovers respectively the peeling and preparation losses in our study. Baker et al. (2009) also reported from Australia that single households tend to have the highest per capita food loss rate, which is also consistent with our findings.

As Koivupuro et al. (2012) declare in general for household food waste that "the influences of several factors on the amount of wasted food" are very useful when trying to understand consumer behavior and attitudes in relation to discarding of edible food and planning food waste reduction initiatives", this is even more valid for loss data focusing on one single product. Even if most of the factors examined to have an impact on the amount of potatoes being wasted, are socio-demographic factors, we can try to examine what these people do better than those. For example, we can speculate what older people do better than younger ones. Then we can try to influence the attitudes and the behaviors of the younger people according to attitudes and behaviors of older people. For the examination of several attitudes and behaviors of households with less potato waste compared with those with high potato waste, qualitative consumer research will be needed.

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