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UNIVERSITATEA TEHNICĂ A MOLDOVEI
FACULTATEA TEHNOLOGIA ALIMENTELOR
DEPARTAMENTUL TEHNOLOGIA PRODUSELOR ALIMENTARE

ACTIVITATEA APEI ÎN PRODUSELE ALIMENTARE
MONOGRAFIE

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Monografia reprezintă o sinteză generalizată a studiilor teoretice și practice în domeniul activității apei privind calitatea și siguranța produselor alimentare. În lucrare este argumentată influența activității apei asupra reacțiilor chimice și biochimice din alimente, influența asupra proprietăților reologice și stabilității microbiologice a diferitor produse alimentare cum ar fi: produsele de panificație, patiserie și cofetărie, produsele din carne și lapte, cereale, legume și fructe. În monografie sunt incluse unele rezultate obținute în cadrul proiectelor instituționale de cercetare din Universitatea Tehnică a Moldovei, Facultatea Tehnologia Alimentelor.

Monografia este destinată doctoranzilor, masteranzilor, studenților, precum și specialiștilor în industria alimentară.

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CUPRINS

ABREVIERI ȘI SIMBOLURI	4
INTRODUCERE.....	5
1. APA ÎN ALIMENTE	8
2. CONCEPTUL DE ACTIVITATE A APEI	11
2.1. Importanța activității apei în sistemele alimentare	11
2.2. Izotermele de sorbție și desorbție	17
2.3. Histerezisul și factorii care afectează histerezisul	21
2.4. Modificarea activității apei în izotermie	23
2.5. Factorii care influențează activitatea apei	26
2.6. Conceptul de tranziție a sticlei	32
3. INFLUENȚA ACTIVITĂȚII APEI ASUPRA REACȚIILOR CHIMICE ȘI BIOCHIMICE DIN ALIMENTE	38
3.1. Oxidarea lipidelor	40
3.2. Activitatea enzimatică	43
3.3. Activitatea nonenzimatică	45
3.4. Efectul activității apei asupra microbiotei	48
3.5. Combinarea monitorizării activității apei cu alte tehnici de conservare	61
4. ACTIVITATEA APEI ȘI PROPRIETĂȚILE REOLOGICE	64
5. STUDIUL ACTIVITĂȚII APEI ÎN PRODUSELE ALIMENTARE	74
5.1. Formele de legare a apei cu substanțele alimentare și rolul lor în formarea structurii produselor.....	74
5.2. Activitatea apei, stabilitatea și calitatea produsului	77
5.3. Umiditatea și activitatea apei în cereale	80
5.4. Activitatea apei în produsele de panificație	82
5.5. Activitatea apei în produsele de cofetărie	93
5.6. Rolul a_w în ingredientele de fructe și legume pentru alimentele multicomponente	97
5.7. Modificarea activității apei în produsele de patiserie și cofetărie la depozitare.....	103
5.8. Activitatea apei în fructe și produse conservate	111
5.9. Activitatea apei în produsele lactate	141
5.10. Activitatea apei în carne și produsele din carne	160
6. RELAȚIA DINTRE PH ȘI ACTIVITATEA APEI ÎN ALIMENTE	172
BIBLIOGRAFIE.....	186

ABREVIERI ȘI SIMBOLURI

FDA – Food and Drug Administration, Administrația americană pentru alimente și medicamente (FDA)

FSA – Food Standards Agency

GHP – Good Hygiene Practices

GMP – Bunele practici de fabricație

USDA – US Department of Agriculture

GAB – Modelul Guggenheim-Anderson-de Boer

NSF International – Organizația americană de testare, inspecție și certificare a produselor, servicii de gestionare a riscurilor (fondată în 1944)

ISO – International Organisation for Standardization

FAO – Food and Agriculture Organization of the United Nations

HACCP – Hazard Analysis Critical Control Point

ICMSF – International Commission on Microbiological Specifications for Foods

a_w – activitatea apei

a_{wc} – activitatea critică a apei

U – umiditatea

ERH – umiditatea relativă de echilibru

T_g – temperaturi de tranziție

INTRODUCERE

Apa este constituentul cel mai abundent al alimentelor, iar din punct de vedere al siguranței alimentare, este cea mai semnificativă. Prezența, cantitatea și natura apei determină multe procese chimice și biochimice importante în controlul calității și siguranței produselor alimentare. În multe planuri HACCP, activitatea apei (a_w) este frecvent menționată ca un parametru intrinsec necesar în siguranța produselor alimentare. În timp ce majoritatea dintre noi înțelegem importanța a_w , adesea nu reușim să conștientizăm semnificația rolului acesteia. O înțelegere adecvată a rolului apei, în special a activității apei (a_w), poate contribui la elaborarea unor planuri de siguranță alimentară argumentate științific. Datorită rolului său specific în diverse reacții chimice și biochimice într-o matrice alimentară, o înțelegere corectă a funcției apei este crucială.

Activitatea apei în produsele alimentare depozitate reprezintă o problemă pentru toți specialiștii în domeniul științei alimentelor. Aceasta trebuie ținută sub control pentru a fi utilizată în dezvoltarea produselor, controlului calității și siguranței alimentelor.

Subiectele acestei lucrări au fost selectate din diverse surse naționale și internaționale, precum și din cercetările proprii, pentru a oferi masteranzilor și doctoranzilor o înțelegere globală a mecanismelor prin care a_w influențează calitatea, durata de depozitare și siguranța produselor alimentare. Conceptele privind utilizările practice ale a_w pentru formatarea, prelucrarea și depozitarea alimentelor sunt ilustrate prin exemple practice din industria alimentară, din studiile de cercetare, care vor facilita aplicarea lor ulterioară de către profesioniști în propriile laboratoare și secții de producție.

Indicatorul "activitatea apei" (a_w) determină încărcătura microbiologică, natura și direcția transferului de masă, intensitatea proceselor biochimice și fizico-chimice care apar în produsele alimentare și caracterizează astfel calitatea, stabilitatea și siguranța acestora.

În anii 1950, conceptul *activitatea apei* a fost propus pentru a determina stabilitatea alimentelor. În 1953, William James Scott a arătat că pentru creștere microorganismele au nevoie de apă în stare liberă (Barbosa-Canovas G.V. ș.a., 2007). În anii 1980 au fost publicate date importante privind stabilitatea alimentelor în funcție de a_w (Pühr D.H. ș.a., 1992; J. Chirife ș.a., 1978; Barbosa-Cánovas G.V., ș.a., 1998). Conceptul de *tranziție în sticlă* (Glass Transition Concept) a fost propus pe scară largă în anii 1980, deși acest concept a apărut inițial în literatura de specialitate în anii 1960. Actualmente, există sugestii publicate recent conform cărora „dinamica apei” poate fi aplicată în locul determinării a_w pentru a prevedea stabilitatea microbiană a sistemelor alimentare cu umiditate înaltă și intermediară (Sandulachi E., 2012; Rahman M.S., 2010; Sablani S.S. ș.a., 2006 ș.a.).

Conceptul a_w și conceptul de tranziție în sticlă oferă o bază științifică solidă a stabilității alimentelor în timpul uscării, congelării și depozitării. În prezent, se acceptă în general că a_w este legată mai strâns de proprietățile microbiologice, biochimice și fizico-chimice ale alimentelor decât de conținutul total de umiditate (Eliasson L. ș.a., 2019; Torri L. ș.a., 2010; Barbosa-Canovas G. ș.a., 2007; Saleem Q., 2005).

Modificările specifice ale culorii, aromei, texturii, stabilitatea și acceptabilitatea produselor alimentare naturale și procesate au fost asociate cu anumite limite ale a_w (Rahman M.S. și Labuza T.P., 2007; Barbosa-Canovas G. ș.a., 2007). Alături de temperatură, a_w este considerată unul dintre cei mai importanți parametri în conservarea și prelucrarea alimentelor (Barbosa-Canovas G. ș.a., 2007; S. Sureshkumar ș.a., 2006). Stabilitatea alimentelor, prin studierea și argumentarea factorilor care controlează stabilitatea lor microbiană sau degradarea fizico-chimică și enzimatică, este o problemă importantă atât pentru oamenii de știință, cât și pentru specialiștii în domeniul alimentar (Schiraldi E. ș.a., 2012; Sant'Ana A.S. ș.a., 2008; Roudaut G., 2007; Rahman M.S. și Labuza T.P., 2007).

Importanța a_w în produsele alimentare a fost recunoscută în Europa cu 30 de ani în urmă, fiind ulterior preluată de FDA și USDA, bunele practici de fabricație (GMP), analiza riscurilor prin punctele critice de control (HACCP) și cel mai recent în cadrul Proiectului Internațional din standardul NSF. Scopul acestor regulamente este de a descrie în detaliu cerințele specifice, punctele

critice de control și metodele pe care industria alimentară trebuie să le urmeze pentru a se asigura că produsele sunt fabricate în condiții de siguranță. Actualmente, a_w reprezintă unul dintre parametrii critici ai cerințelor HACCP (analiza pericolelor și punctelor critice de control) (Talpia M.S. ș.a., 2007; FAO, 1997).

Factorii care influențează stabilitatea produselor alimentare finite sunt:

- umiditatea și a_w ;
- condițiile de păstrare (temperatura, umiditatea relativă a aerului, tipul de ambalaj, compoziția chimică a aerului etc.).

Având în vedere că alimentele cu a_w redusă sunt supuse totuși modificărilor chimice, biochimice și microbiologice, indicatorii duratei de valabilitate se stabilesc în conformitate cu modificările admisibile în calitatea produselor (Ramiez M.L. ș.a., 2006; Walstra P., 2003). Deci, atât monitorizarea, cât și reglarea a_w în alimente este o problemă de importanță majoră. În tabelul 1 sunt incluși factorii intrinseci și extrinseci de care trebuie să se țină cont la conservarea produselor alimentare, selectați din diverse surse bibliografice.

Tabelul 1. Caracteristici intrinseci și extrinseci^a

<i>Factori intrinseci</i>	<i>Factori extrinseci</i>
pH și tipul de acid prezent ^b	Temperatură (durata de producție, depozitare, distribuție și realizare) ^b
a_w ^b	Ambalare ^b
Eh	Atmosferă de gaze
Barieră naturală	Umiditate relativă
Conținut nutrițional de alimente și disponibilitatea lor	Prelucrare alimentară
Substanțe antimicrobiene	Bune practici de fabricare și igienă
Microbiotă	Etichetare ^c
Calitatea microbiologică a ingredientelor	Depozitare și distribuție
Rețeta și compoziția alimentului	Practici ale consumatorilor
Asamblare și structură	Procese bazate pe HACCP

^a(Abbey Court, 2014; Jay J.M. ș.a., 2005; Food & Drug Administration, 2013).

^bPentru majoritatea operatorilor din sectorul alimentar, cele mai importante caracteristici intrinseci și extrinseci sunt pH, activitatea apei, temperatura de depozitare și ambalare a alimentelor.

^cPoate avea legătură și cu caracteristicile intrinseci, în funcție de natura datelor.

O modalitate de dezvoltare a produselor noi reprezintă conservarea prin obstacole, care are drept bază acțiunea combinată a a_w (nivel scăzut) cu alți factori de conservare. Cercetătorul L. Leistner (1994) a introdus conceptul de *obstacol* sau *efect de obstacol*, remarcând că în majoritatea produselor alimentare utilizarea combinată a diferitelor metode de conservare (obstacole) contribuie la stabilitatea microbiologică și siguranța lor (Sandulachi E., 2012; Nicolau A. ș.a., 2006; Jay J.M. ș.a., 2005; Labuza T.P. ș.a., 1976). Activitatea apei este frecvent utilizată ca punct de control critic pentru analiza pericolelor și puncte critice de control în programele HACCP. Probele produsului alimentar trebuie testate pentru a se asigura că valorile a_w se află într-un interval specificat pentru calitatea și siguranța alimentelor. Măsurătorile pot fi făcute în mai puțin de cinci minute și sunt frecvent incluse în majoritatea fluxurilor moderne de producere a alimentelor. În unele cazuri, monitorizarea a_w în produse alimentare este cerută de reglementările FDA. Cu toate acestea, este important să știm că doar scăderea a_w a unui aliment nu este în sine un pas letal pentru toate microorganismele, devreme ce unii patogeni pot supraviețui. În cazul în care a_w este utilizată ca CCP sau specificată ca punct de control, validarea produsului și a procesului trebuie să se bazeze complet pe limitele exacte ale valorilor a_w .

Focarele recente legate de alimentele cu umiditate scăzută au trezit un mare interes al specialiștilor din centrele și industriile de cercetare pentru a găsi soluții ale acestor probleme. Industria alimentară este interesată de tehnologiile de prelucrare termică pentru a reduce agenții patogeni din alimentele cu umiditate scăzută. Cu toate acestea, cunoașterea factorilor care influențează rezistența termică a agenților patogeni este necesară pentru a dezvolta și a implementa protocoale adecvate de prelucrare. Acești factori sunt:

- valorile a_w ;
- mobilitatea proteinelor;
- compoziția matricelor alimentare;
- caracteristicile microorganismelor-țintă.

Cercetările anterioare publicate au identificat importanța a_w , care poate fi cel mai semnificativ factor ce influențează rezistența termică a agenților patogeni din alimentele cu umiditate scăzută (Wongwiwat P. și Wattanachant S., 2015; Labuza T. și Altunakar B., 2007). Dependența a_w de temperatură este esențială și trebuie luată în considerare când se elaborează protocoale și ecuații relevante pentru mai multe tehnologii de prelucrare termică. Efectul temperaturii asupra a_w dintr-un aliment este specific produsului. În unele produse, a_w crește odată cu creșterea temperaturii, în altele scade odată cu creșterea temperaturii, în timp ce majoritatea alimentelor cu umiditate ridicată au o schimbare neglijabilă a a_w odată cu temperatura. Prin urmare, nu se poate prevedea nici cel puțin direcția schimbării a_w odată cu temperatura, deoarece depinde de modul în care temperatura afectează factorii ce controlează a_w în aliment (Jay J.M. ș.a., 2005; Fontana A.J., 2001).

Monitorizarea a_w este un punct de control critic pentru mulți producători și ar trebui încorporată în multe alte programe de siguranță alimentară. Prioritatea numărul unu constă în protejarea consumatorului. Încorporarea testării a_w și a altor analize bazate pe știință într-un program de siguranță alimentară vor ajuta la asigurarea calității și inofensivității produselor alimentare. O colaborare strânsă între instituțiile de cercetare și industria alimentară, precum și sprijinul organizațiilor guvernamentale va asigura rezultatele pozitive necesare pentru a depăși această provocare (Roopesh M. Syamaladevi ș.a., 2016).

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